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VOL. IX. NEW YORK, APRIL, 1904. No. 2.

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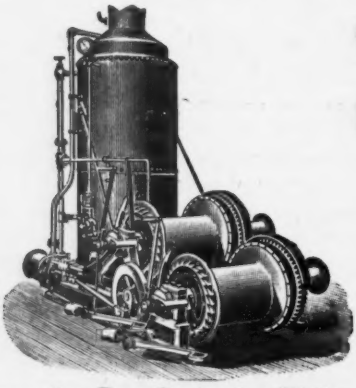

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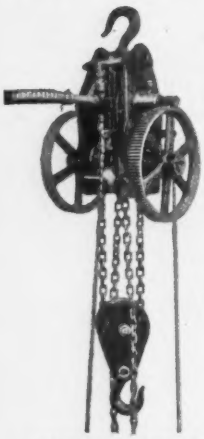

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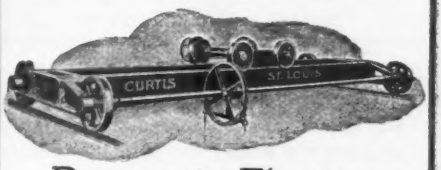

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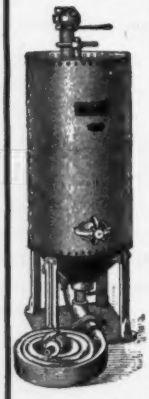

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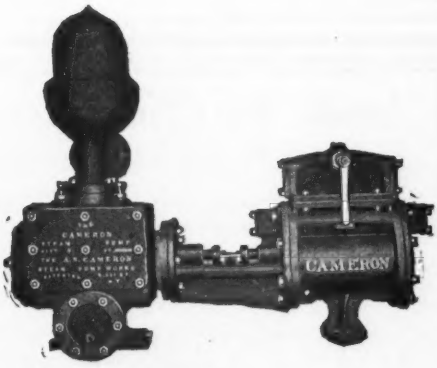

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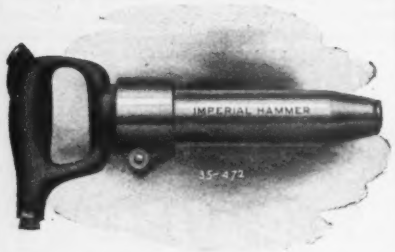

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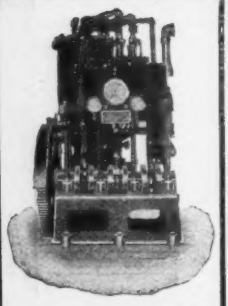

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VOL. IX. APRIL, 1904. NO. 2

The Hudson River Tunnel a Reality.

New York City and its Jersey neighbors are at last connected by a tunnel under the Hudson river. The news of this achievement is regarded with satisfaction by the entire country. As a matter of fact, the victory was won months ago when the engineers in charge of this enterprise found that their carefully planned operations were working with success and that it would only be a question of months before the two headings could be joined under the river. The fact that the two headings have met and that it is now possible to walk from one side of the Hudson to the other, must, after all, bring a feeling of gratitude and satisfaction to the men who have brought this to pass, even though they realized months ago that it was only a question of time.

This latest achievement of Chief Engineer Chas. M. Jacobs is really a victory for compressed air. It has proven, beyond dispute, that it is indispensable for subaqueous tunneling. When the enterprise was started, 30 years ago, compressed air was tried. Its use for that form of tunneling was still in an experimental stage, but it demonstrated its possibilities. When operations were resumed two years ago by the Hudson Improvement Company, subaqueous tunneling by the shield method was better understood. With the modern methods the enterprise was carried through with remarkable speed and without loss of life which marked the first undertaking. Its success has resulted in the adoption of that method for other enterprises of a similar nature so that now half a score of headings have either been started or are about to be under the three rivers which surround Manhattan Island.

While one tunnel under the Hudson river has been completed, a similar parallel bore is now under construction and will also be used by the N. Y. and N. J. Railroad Company for its lines of electric cars to carry passengers between New York and the Jersey shore. The second tunnel is going forward rapidly and by the same methods as were used in the first. A description of these methods, together with the compressed air plant and equipment, was given in COMPRESSED AIR for September, 1903.

Compressed Air in Naval Warfare.

At the outset, at least, compressed air has figured prominently in the Russo-Japanese War. Three of Russia's most powerful warships in the Far East have been seriously damaged, if not permanently incapacitated, by Whitehead torpedoes, which derive their energy for propulsion from compressed air.

While the original torpedo was nothing more than a submarine shell fired

from a gun the mouth of which was below or close to the water line, the improvements made in this instrument of naval warfare have resulted in a craft able to navigate and automatically direct its own movements independent of the power which first launches it on its course of intended destruction. The modern Whitehead torpedo, which is used by the Japanese and the American navies, is really a submarine craft equipped with an engine of its own. A small but very powerful three-cylinder engine, operated by compressed air, is used to drive the screw which propels it. The compressed air is contained in a reservoir which answers a double purpose, that of furnishing motive power and a buoyancy chamber which will keep the craft from going to the bottom as soon as it is launched.

Various other methods of supplying power have been tried, but none with success. Compressed air has these two important advantages which no other means of power transmission can offer. While compressed air has weight, it is relatively very light when compared with any other means of supplying power. And this lightness is an all-important feature for such a device. Then it can be stored for an indefinite time with the knowledge that it will be ready for action without a moment's warning or any attention. As long as the pressure tank, which contains it, is air tight, the compressed air is absolutely reliable.

Many experiments have been made with electricity, and it is possible that the storage battery may show a practical way to direct the torpedo's course when speeding towards its destination without connection. There is little likelihood, however, that any means will be found to supersede compressed air for driving torpedoes.

HON. WILLIAM R. GRACE.

It is with deep regret that we have to note the death of the Honorable William Russell Grace, President of The Ingersoll-Sergeant Drill Company, the largest of the manufacturers of air compressors and general mining machinery. Mr. Grace has been connected with the Company for over fifteen years, having been its President for more than ten years, during which time the concern grew and prospered, spreading out not only over this continent, but also abroad.

At a regular meeting of the Directors of the Company, held March 24, 1904, the following resolution was unanimously adopted:

"As God in his wisdom has seen fit to take away our President and friend, William Russell Grace,

"Resolved, That this Board wishes to express its deep sorrow at the loss of one whose wise counsel and able direction during the past fifteen years have brought progress and prosperity to the Company. We mourn the loss of a citizen whose public spirit has left a lasting impression for good; of a business master who won success by industry joined at all times with sterling integrity; of one whose charity always sought the weak and lowly and who gave quietly and bounteously; of one whose good fellowship was well known to those who by close association really knew him; of one who was great in many things, but greatest in his home, as husband, father, brother and friend. We extend to his widow and family our deep sympathy."

William Russell Grace ran away from home as a school-boy. From his first independent step until he achieved the dignified position of a leading merchant of the United States, his career is a record of untiring energy, great perspicuity and unblemished integrity. It is only recently that he has relinquished the active control of his widespread interests, to place them in the hands of the younger men who surround him, and whom he has trained and inspired with the same principles that brought him success.

He was born May 10, 1832, at Riverstown, County Cork, Ireland. His father, James Grace, and his mother, Ellen Mary

Russell Grace, were both of distinguished family. The Graces trace their descent to Raimond Le Gros, of the ancient Norman family of that name which migrated to

THE LATE HON. WILLIAM R. GRACE.

Ireland. W. R. Grace's father, James Grace, seriously compromised his fortunes by his generosity in the famine of 1847-1848 in Ireland, when he provided work on his estates for the people of the entire surrounding district, which alleviated much suffering.

When W. R. Grace fled school and shipped before the mast bound for New York his father was in comfortable circumstances. In the year he remained in New York the young man took no step and

made no connection that was of service to him in his subsequent progress. He found employment in a small shop in Chatham Street, which he left to return to Ireland. Shortly afterward he accompanied his father in the bark "Louisa" to Callao, Peru, whither the elder Grace went with the idea of mending his impaired resources. The father saw nothing there sufficiently alluring to warrant his remaining, but the son entered the commercial house of John Bryce as a clerk. This was the beginning of his real commercial life, out of which came fame and fortune.

The ability displayed by young Grace was speedily manifested. In a few years it was recognized by his being made partner. The style of the firm soon became Bryce, Grace & Co. Through the combined elements of the established business, the energy that he instilled, and the broad field open to it, the house steadily grew in importance, its operations were broadened, and it came to be the acknowledged leading American house doing business in Peru.

Early in the war of the rebellion the English and native houses of Callao decided to refuse credit to vessels of the United States Navy, which then called frequently at that port, the chief basis of naval supplies on the West Coast of South America. Although not at the time an American citizen, Mr. Grace unhesitatingly placed the resources of his house at the disposal of the vessels of our navy, and his action was subsequently recognized as having relieved this Government from an exceedingly difficult position.

In 1865 W. R. Grace, having acquired a competency, retired from business in Peru. His health was seriously impaired. His brother, M. P. Grace, who had previously joined him, took up the management of the business. The firm became Grace Brothers & Co. It continued to grow in importance and prosperity.

Mr. Grace was proud of his race. He assisted a large number of Irishmen to migrate from the congested districts to this country, advancing the means required for the journey. He was always glad to state that he never lost a single dollar of the money so invested, while many of those he assisted tendered him interest in repaying their obligations.

In 1868 Mr. Grace established in New York the business which now bears his name. It grew steadily in importance, established other houses in commercial centres abroad, each of which worked for the common welfare of all. In 1894 the business was incorporated in Connecticut with a capital of $6,000,000. Its interests are far more vast than its capital indicates. There is the firm of Grace Brothers & Co., Ltd., in London, branches in San Francisco, Cal., Lima and Callao, in Peru, and Valparaiso, Santiago and Concepcion in Chile, while all have intimate commercial and financial relations with leading business and banking houses in the several spheres of their activity.

The position of the firm has been preeminent for many years. As early as 1886 the foreign creditors of Peru besought it to undertake the settlement of their claims against that Government. Through the efforts of the firm, under the direction of Michael P. Grace, an adjustment was effected between Peru and her creditors in 1890 that involved the enormous total of $250,000,000 gold.

The firm has always commanded exceptional ability in organization and the development of new business, the master hand of W. R. Grace being evident always. He has said his success consisted not in any marked ability he possessed personally, but in his faculty of surrounding himself with men of broad gauge, combining their industry and intelligence with his resources, experience and judgment, out of which came the commanding position of the whole.

W. R. Grace established the pioneer direct steamship service between New York and the west coast of South America in 1892. The New York and Pacific Steamship Co. is owned and operated by the house. Its fleet of seven large steamers, constructed specially for their trade, plies between this port and Guayaquil, in Ecuador, by way of the Straits of Magellan. Mr. Grace and his partners own and control important nitrate of soda properties in Chile, a sugar estate and cotton mill in Peru, are closely identified with railroad interests in both countries.

Mr. Grace was prominent in conservative corporation circles in New York. He was President of W. R. Grace & Co., Ingersoll-Sergeant Drill Co., Haeseler-Ingersoll Pneumatic Tool Co., Trustee of the New York Life Insurance Co., Lincoln Safe Deposit Co., Director of the Central and South American Telegraph Co., City Trust Co., Lincoln National Bank, Northern Insurance Co., Terminal Warehouse Co., Terminal Improvement Co., Grace Brothers & Co., Ltd., and the Evergreen Cemetery.

He was conspicuous as an independent Democrat, both locally and in national politics. He was twice elected Mayor of New York, independently, in 1880 and in 1884, and in both of his terms as Mayor he applied to the City's business the same methods and untiring energy that had characterized his commercial life. His was a leading figure in the independent Democratic movement whose followers became known as "anti-snappers." Shrewd political observers give him and his associates the credit for the nomination that gave Cleveland his second term. W. R. Grace was a party man whose partisanship never carried him to the extent of indorsing or supporting actively any candidate for municipal, State or national office of whose integrity he was not confident or whose candidacy he did not honestly believe to be in the interest of the whole body politic.

Socially Mr. Grace was popular. He had an immense following of friends who were firmly attached to him for his loyalty, geniality and spontaneity. He was never an active club man, although he belonged to the Metropolitan, Manhattan, Lawyers', Reform, Catholic, Down Town, Westchester County and other clubs. He was a member of many societies of philanthropic, historic and educational object.

In his charity and philanthropy Mr. Grace was unostentatious and always practical. He befriended many people and advanced causes in such a way that credit therefore could not come home to him. In 1879, a famine year in Ireland, he was a large contributor to the relief expedition organized here, and personally took charge of the despatch of the U. S. S. "Constellation," which carried a cargo of food to the sufferers. A few years ago, in hard times and when the severe winter was causing great suffering among the poor of the city, Mr. Grace sent checks, but not in his own name, for $1,000 each to a large number of the St. Vincent de Paul conferences throughout the city, knowing that in this way the most speedy relief to the greatest number of deserving people would be accomplished. And probably not more than twenty-five people knew of that action at the time or since.

In 1897 Mr. Grace and his brother Michael established the Grace Institute on Sixtieth street, near Amsterdam avenue. It educates young women in domestic sciences and occupations that will afford them the means of self-support. The work was dedicated by the brothers to the memory of their father and mother. It is supported exclusively by the members of the family. It now educates over 750 young women annually and is conducted on nonsectarian lines that draw to it pupils of all races and religious beliefs.

Mr. Grace was also President for many years of the Sevilla Home for Children.

The home life of W. R. Grace was recognized as ideal by all who were privileged to see it. He married Miss Lillius Gilchrist, daughter of George W. Gilchrist, of St. George, Me., who was interested in American shipping. His daughter accompanied him on a voyage to Peru, where Mr. Grace first saw her, and she subsequently went to Peru to become his wife. Their children are Alice, wife of A. F. D'Oench, Joseph P., Lilias, wife of George Edward Kent, Louise Natalie and W. R. Grace, Jr. His homes were at No. 31 East Seventy-ninth street and his beautiful country seat, "Gracefield." at Great Neck, Long Island, in which he was greatly interested, and where he spent the major portion of each year.

Air Compressor Plant at Marshall Field Store, Chicago, Ill.

Standard practice in regard to the installation of air compressors has until recently consisted of direct or indirect steam-driven equipment. Where the demand for air was small, "Straight Line" machines were used chiefly, on account of low first cost. These "Straight Line" compressors, however, have some objections, the greatest being in governing them satisfactorily.

Where conditions were favorable and the expenditure justified, these objections were overcome by the installation of duplex compressors. This type of machine can be equipped with suitable governors so that it will operate only enough to supply the demand for air, stopping and starting automatically.

Steam-driven equipment, however, requires a boiler plant, and in many cases it is unwise or prohibitive to have such, especially in department stores, office buildings, and the like, in large cities, where all available space is made much more productive than if it were devoted to a boiler-room where power could be

produced a little more cheaply than it could be bought from power companies.

As all cities have electricity "on tap" at reasonable rates, engineering practice of late years has been to equip the above-mentioned stores, buildings, etc., with electric driven equipment, and this has necessitated the installation of electric-driven air compressors.

The plant which is the basis of this article was part of the machinery installed in the palatial store recently erected by

compressors are not compounded as the dimensions indicate, but each cylinder is independent of the other, thus allowing a supply of air at two different pressures to be obtained from each machine. The low pressure cylinder of each compressor has a capacity of 413 cubic feet of free air per minute, and the high pressure cylinder of each compressor has a capacity of 236 cubic feet of free air per minute, at a speed of 150 revolutions per minute.

The larger compressors are connected

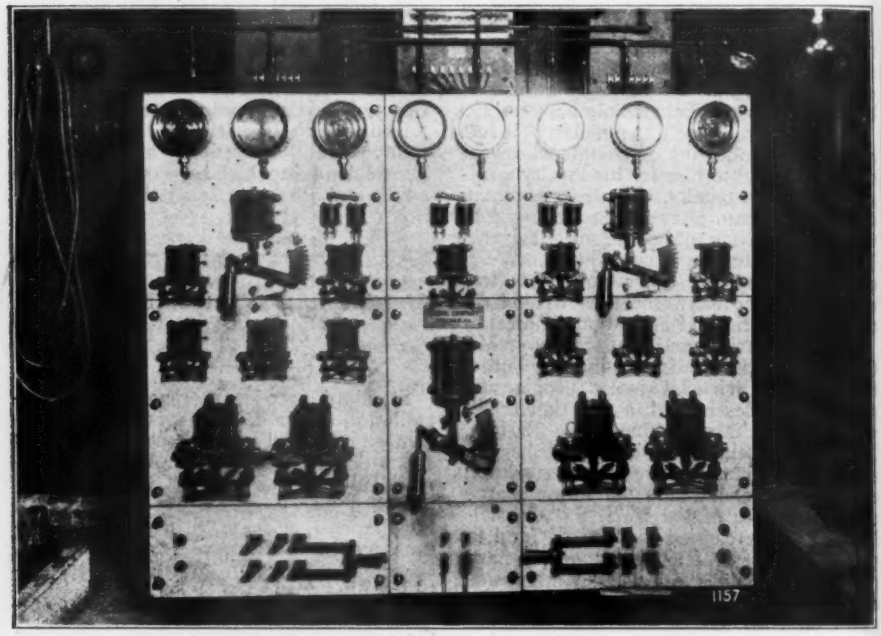


FIGURE 1—ELECTRIC CONTROLLING APPARATUS AT MARSHALL-FIELD BUILDING.

Marshall Field at Randolph and State streets, Chicago.

The air compressors were furnished by the Ingersoll-Sergeant Drill Company, of New York, and are three in number, two of the Class "J" type having cylinder dimensions 16¼ and 12¼ inches by 12 inches, and one of the Class "E" type having cylinder dimensions 8 by 8 inches, see Figures 2 and 3. The Class "J"

by belt to two 50 horse-power Form "D" open-type compound-wound Crocker-Wheeler motors, the small compressor being belted to a 7½ horse-power Form "F" open-type compound-wound Crocker-Wheeler motor, see Figure 2. Both of the larger units are connected to the same piping systems and only one is operated at a time, the other being held in reserve. The high-pressure cylinder of each of the

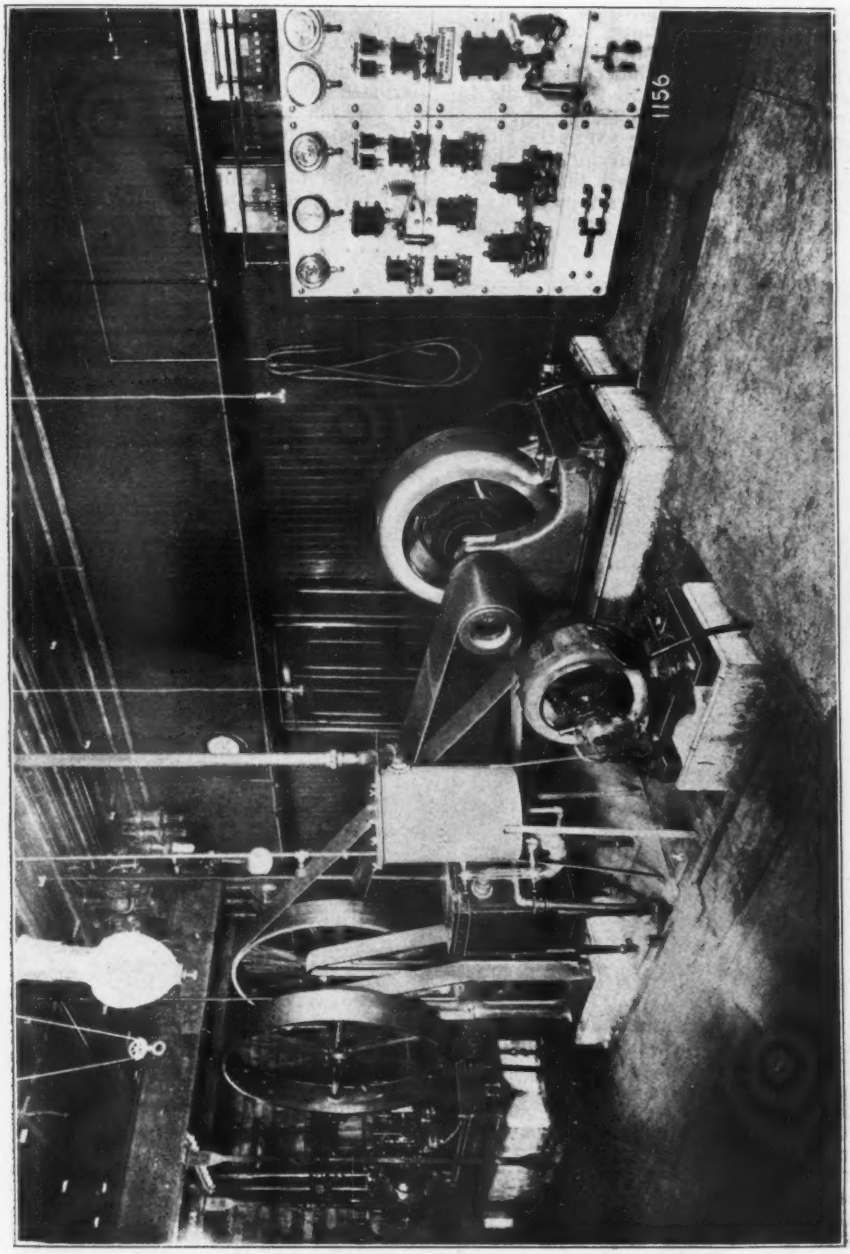


FIGURE 2—SMALL CLASS "E" COMPRESSOR AT MARSHALL-FIELD BUILDING.

larger compressors furnishes air at 65 pounds pressure for carpet cleaning, fur cleaning and various other purposes.

The low pressure cylinder furnishes air at 25 pounds pressure, used principally to operate pneumatic self-opening elevator doors, of which there are 500 in the building, and also to supply air for the Shone sewage ejectors. There are three sewage ejector plants located at various points in the building, one having a nominal capacity of 200 gallons per minute, another of 100 gallons, and the third of 50 gallons.

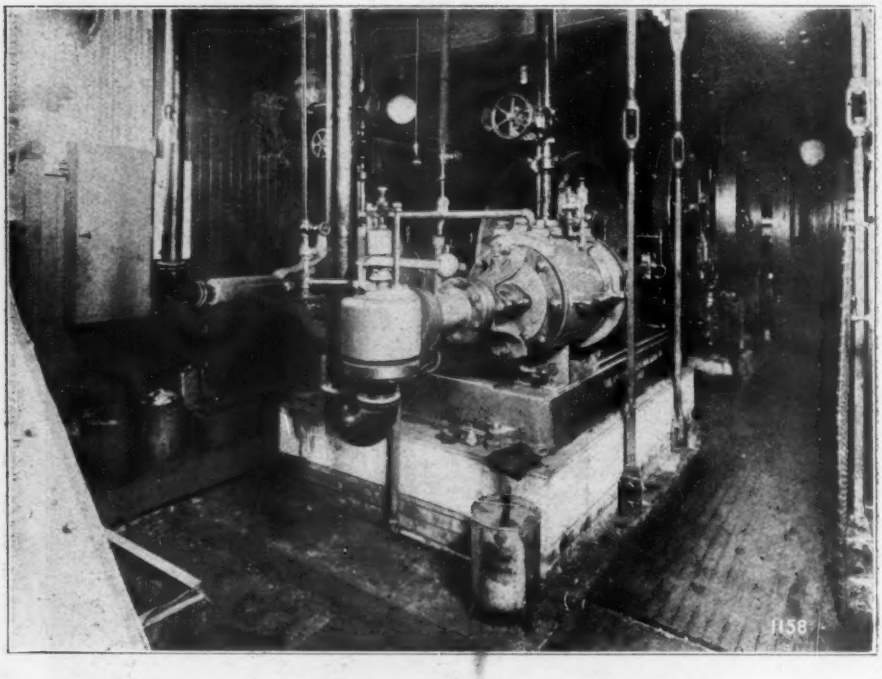


FIGURE 3—CLASS "J" AIR COMPRESSOR AT MARSHALL-FIELD BUILDING.

The small compressor supplies air at 45 pounds pressure for the use of doctors and dentists located in the office building adjoining the store and under the same management. This compressed air must be thoroughly clean and pure, so the compressor obtains its supply from a small tank containing a number of pans arranged so that water drips from one to another, the air being drawn upward through the spray formed by the dripping water. Before the air reaches the intake of the compressor it is made to pass through a box containing several layers of sterilized cotton batting, which removes any dirt not washed out at first, see Figure 2, between small motor and compressor. To keep the air clean after it is taken into the compressor there are no lubricants used in the cylinder.

It is evident that since the demand for air is intermittent, and also since each cylinder of the Class "J" compressor supplies an independent air system, economical operation demands that some means must be provided for starting and stopping the compressor automatically while maintaining a uniform pressure in each system. When either system falls to the desired minimum pressure, the controlling apparatus must be such that the compressor will start and be maintained in operation until the pressure has reached

the desired maximum in this system regardless of the demands or existing pressure in the remaining system connected to the other cylinder of the compressor.

Uniform pressure in the high pressure system is maintained by connecting the high pressure discharge with the low pressure receiver. Now if the high pressure system reaches its maximum first, an automatic valve arrangement prevents further discharge into the high pressure receiver and allows the high pressure cylinder to discharge into the low pressure receiver, until the low pressure system reaches a maximum, when the compressor is automatically stopped. Temporarily both cylinders work against the pressure in the low pressure system.

When the plant was first installed, whenever the high pressure system reached a maximum the high pressure air was allowed to spill from the high pressure receiver into the low pressure receiver until it reached its maximum. This scheme was wasteful of power, however, and was succeeded by the method already mentioned of allowing both cylinders to work against the pressure in the low pressure system.

Uniform pressure in the low pressure system is maintained by equipping the inlet of the low pressure cylinder with an Ingersoll-Sergeant A-12 choking controller, so that when the low pressure system reaches a maximum the inlet is choked and no more air is admitted to the cylinder. The choking of the low pressure inlet does not interfere with the high pressure cylinder and it is free to work until it has reached a maximum.

As the motors have to be started and stopped to operate the compressors in this way, it was necessary to also install electric apparatus for controlling the motors. This was done by the Cutler-Hammer Manufacturing Company, of Milwaukee, Wis.

An external view of the apparatus in question is shown in Figure 1, mounted on three panels of white Italian marble, the equipment on each panel controlling one air compressor. The apparatus on the two end panels, which are duplicates, operate the two 50 horse-power motors belted to the Class "J" compressors, while that on the center panel controls the 7½ horse-power motor driving the Class "E" compressor. On each of the end panels mounted on either side of the pressure gauge, at the top of same, are two pressure regulators. These pressure regulators are an adaptation of the pressure gauge to the service of making electrical contact operate the controllers.

The needle of the gauge is provided with an insulating stud which carries a silver needle against the tension of a coil spring from the lower contact, representing the minimum pressure to a second contact corresponding to the maximum pressure desired.

Whenever the pressure in the system falls so that the silver needle makes contact with the lower point, a small relay is energized, thus completing the circuit of the main solenoid switch located at the lower left-hand corner of the panel, which in turn lifts its armature, by which action the circuit is made for the main starter solenoid, shown at the upper portion of the panel. This starting solenoid in attracting its armature causes the attached arm to move over a series of contacts each of which energizes one of the various solenoids, causing each successively to attract its armature, thereby cutting out a portion of the resistance in series with the motor and gradually bringing it up to full speed. The motion of this arm is retarded by an adjustable dash pot, which will permit, it is claimed, any desired rate of acceleration in starting up the motor, regardless of the starting load.

When the compressor has operated for a sufficient length of time to obtain the desired maximum pressure, the needle of the pressure gauge has been carried by the arm of the gauge from the lower to the upper contact point, as a result of which the remaining small relay magnet on the starting panel has been energized, breaking the circuit to the main solenoid switch, causing it to open and stop the motor.

It will be noted that each of the end panels is provided with two of these gauge type regulators mounted one on either side of the pressure gauge, which are so connected that the operation of the compressor is obtained when either the high or low pressure air system demands.

The chief advantage of this method is the economical use of electricity as a motive power, since any attempt to regulate the motor speed by insertion of resistance in the armature circuit is a very wasteful process, whereas under intermittent operation the motor is at rest and consuming no energy, except when re-

quired to run at maximum speed and efficiency.

Apparatus of the multi-solenoid type as mentioned can be operated, it is claimed, with a minimum cost for repairs, the only wearing parts being the auxiliary carbon contacts and copper segments, both of which are easily and cheaply renewed.

In practical operation the knife switch, shown at the bottom of each controller panel, is simply thrown in and the controller left to take care of itself, which it does, maintaining the pressure between the required limits in each of the systems.

In the present instance, as noted, air at three different pressures is furnished for a great variety of purposes, these pressures being easily changed to suit any requirements by a very simple adjustment of the pressure regulators.

No attendance is required, it is said, other than throwing in the switch for starting and opening the same when it is desired to take the compressor out of service.

An examination of the back of the board would show that there is no heavy bus bar work, the main current being brought only to the two lower solenoids at the bottom of the panel, all other wiring being of small size wire, except the connections from the solenoid switches to the resistance which is mounted at the rear.

This plant was installed by the Shone Company, of Chicago, and we are indebted to Mr. H. P. Thompson, of the Shone Company, and to Mr. W. H. Beatty, of the Cutler Hammer Manufacturing Company, for material in preparing this article.

Automatic Air Dust Removing Devices.

The report of a board of New York physicians recently and extensively published in the daily press in reference to the alarming increase of pneumonia and pulmonary consumption and kindred diseases, the direct cause of which is assigned to bacteria conveyed by dust, the preventive recommended is the cleaning of houses and buildings in a dustless manner, the abandonment of feather dusters and the substitution of damp cloths, etc. This report at least shows an urgent demand for a sanitary method of removing dust from our buildings, and to accomplish this we must abandon the crude methods that have been in existence since the flood, and adopt a modern system of pneumatic cleaning.

The Pullman Company was the first to successfully use compressed air to renovate their palace cars, but this system, however, is not applicable to buildings. The Sanitary Compressed Air and Suction Dust Removing Company, of San Francisco, has perfected devices that gather the dust in a building without raising it into the atmosphere, and automatically convey it to a proper receptacle. Its several systems all accomplish this important result, and they are adaptable to stationary plants for buildings, as well as portable apparatus for general service.

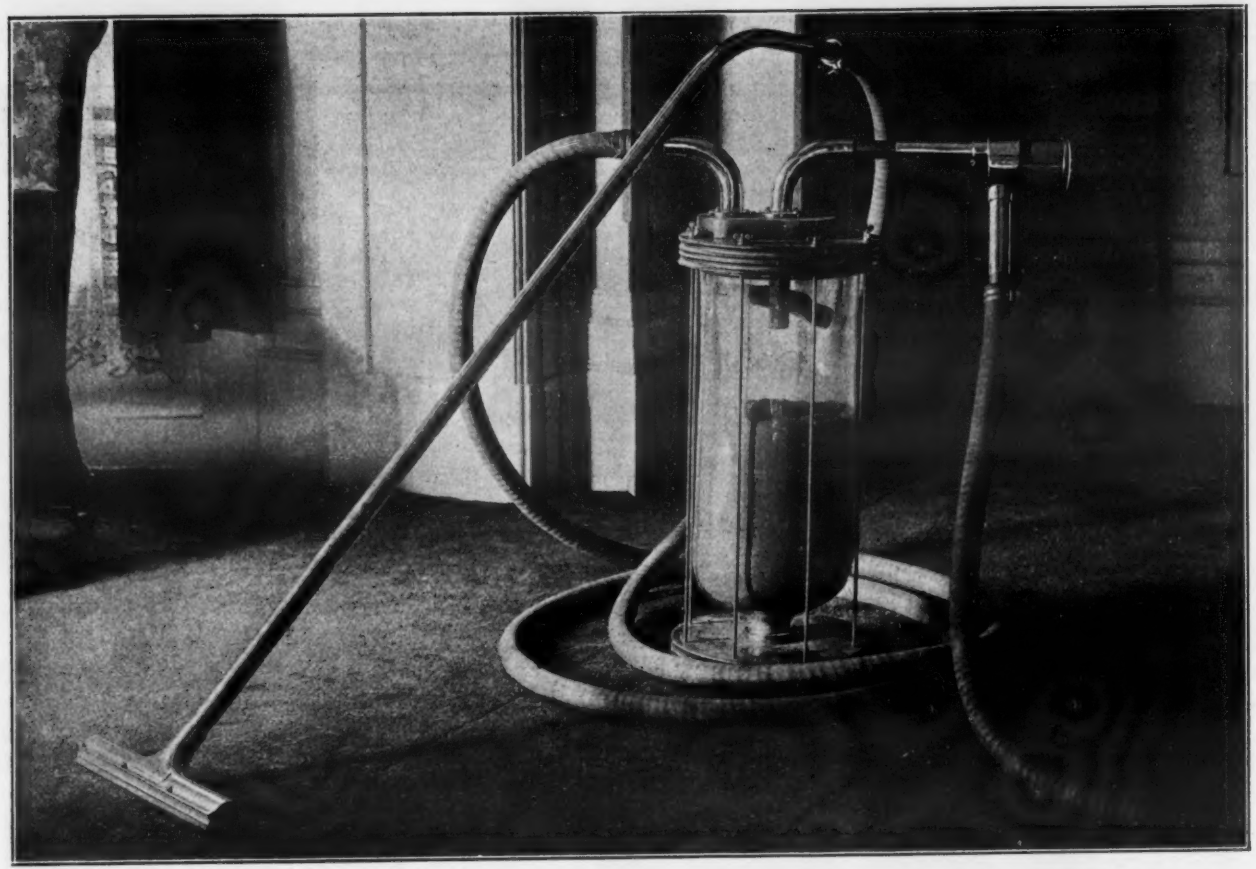
A stationary plant usually consists of a vacuum pump operated by any convenient power, a dust collecting tank, stand pipes and the various cleaning devices. The process is one of absorption, the powerful iron lungs of the vacuum pump breathing in the daily accumulation of dirt at a tremendous velocity. Hotels, office buildings, theatres, apartment houses, etc., provided with this device are sanitarily and economically cleaned, and this process will soon supersede the ineffective methods in vogue. Besides sweeping carpets and floors, it also cleans walls, upholstery, furniture, etc., no dusty nook escaping.

On the other hand, a portable apparatus consists of an air compressor and vacuum pump, which are usually operated by a gas engine, and with a dust arresting tank, all of which are suitably mounted on a wagon. With a renovator, the dust is entirely removed from carpets on the floor and without disturbing the furniture or bric-a-brac in the room. Walls and furniture are also cleaned.

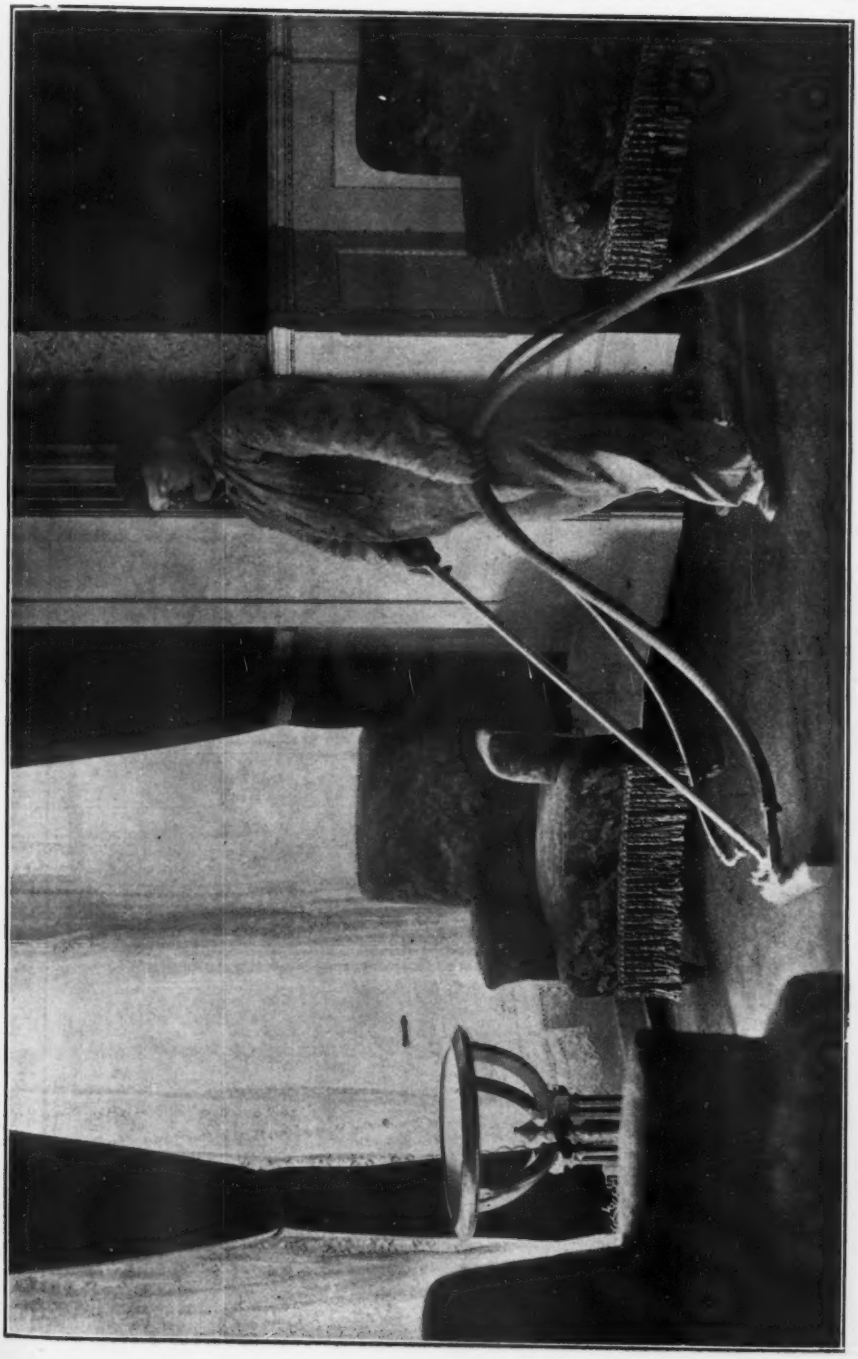
Great ingenuity has been displayed in combining compressed air and vacuum in such a manner that not only is the dust thoroughly removed from the carpet, but automatically conveyed to the wagon without a particle being displaced in the atmosphere. The renovator, as illustrated in one of the accompanying cuts, is so constructed that it operates in corners as well as in the centre of the room, cleaning stair carpets also. It is balanced by the opposing forces of compressed air and vacuum, and glides readily over the carpets, guided by the hand of the operator, and, with valves in the handle, is under his perfect control.

VACUUM SWEEPER OF A STATIONARY PLANT.

Removing dust from carpets and upholstered furniture in Grand Court of Palace Hotel, San Francisco.



GLASS DUST ARRESTER, SHOWING 5¼ GALLONS OF DUST REMOVED WITH ONE VACUUM SWEEPER FROM 560 YARDS OF CARPET IN 1½ HOURS' TIME.



RENOVATOR—COMPRESSED AIR AND SUCTION.

A COMPLETE PORTABLE PLANT.

Having a capacity of renovating 200 yards of carpet per hour

Compressed and ratified air, now used in nearly all the arts and sciences, are destined to find their most useful application in removing dust, germs, vermin and moths from our buildings.

Both the portable and stationary systems are very popular in San Francisco, and are destined to revolutionize the carpet cleaning industry. Science has unquestionably made another stride which materially adds to our health and comfort.

J. P. RAYMOND.

Pneumatic Tool Litigation.

A decision has been rendered by the United States Circuit Court of Appeals in the action brought by the Chicago Pneumatic Tool Company against the Philadelphia Pneumatic Tool Company and the Keller Tool Company for the infringement of the Boyer pneumatic tool patents. The Court asserts the validity of the Boyer patent and declares the hammer manufactured by the defendant companies to be an infringement of five of the claims of the Boyer patent.

The first infringement cited by the Court is in regard to the supply duct. It is covered by claim 42, in which the duct is spoken of as extending through the grasping handle and by claim 45 wherein it is spoken of as extending through the handle without qualification. Quoting from the opinion of the Court on this subject it reads:

"We further recognize that claim 45, which speaks merely of the pressure supply duct extending through the handle, saying nothing about the grasping portion of it, may possibly be entitled to a broader significance than we have thought it necessary to give it or the other associated claims. Accepting the narrower construction, which is all that we need to do, the defendants are nevertheless found within it, and to that extent infringe."

The Court also holds that the claims 42 to 45 regarding the throttle valve have been infringed, and states:

"So far as claims 42 to 45 are concerned, no particular form of construction or mode of operation is specified in them, and none is, therefore, to be imposed; the combination is simply of a throttle valve in the handle in conjunction with a supply duct running through it, and that is all that is required to fulfill their terms."

Further infringement is pointed out by the Court in claims 46, 47 and 48, where descriptive particulars of the throttle valve are given. The opinion states:

"The character of the valve not being involved in this result, and it being unimportant, therefore, whether a flexible rubber clamping tube be employed or not, the only inquiry is with regard to the levers, and of the substantial equivalency of these in the plaintiff's and the defendants' tools there can be no reasonable doubt."

A lengthy comparison of the construction of the tools is made. The opinion also reviews previous patents on the subject and concludes with the following paragraph:

"The question of patentability is also raised, but we will not stop to discuss it. Convinced as we are that the plaintiff has supplied features that have brought success, where others who have preceded him failed, we are not inclined to scan narrowly the means by which it has been obtained. The mechanical elements combined are no doubt old, and so, to a certain extent, may be the result accomplished. But nowhere do we find the same combination employed to produce it, and the efficiency attained is so much in advance of that which had gone before as of itself to suggest, if it does not prove, the exercise of inventive skill.

"Holding, therefore, that the patent is valid, and that claims 42, 45, 46, 47 and 48 have been infringed, the decree of the Court must be reversed, the bill reinstated and the case referred to a Master for an account."

A Substitute for Looped Hose on Traveling Air Hoists.

Possibly the most troublesome feature, and certainly the greatest nuisance in connection with the use of traveling cranes and hoists in which compressed air is used as the actuating medium, is the difficulty commonly attendant upon the delivery fluid to the moving mechanism. One of the most simple yet really cumbersome methods is that wherein a flexible hose is used; its length somewhat exceeding one-half the total longitudinal travel of the hoist; connected to a fixed source of air supply located about midway of the runway; and supported at intervals of its length by suitable trolley

Having a capacity of renovating 200 yards of carpet per hour

connections such as to allow the hoist entire freedom of travel, the hose hanging in loops between its points of support. Various means to avoid the use of this rather crude method have been tried, and numerous devices have been contrived for use in this connection. Probably the latest of the appliances devised for this purpose is illustrated in the engravings herewith.

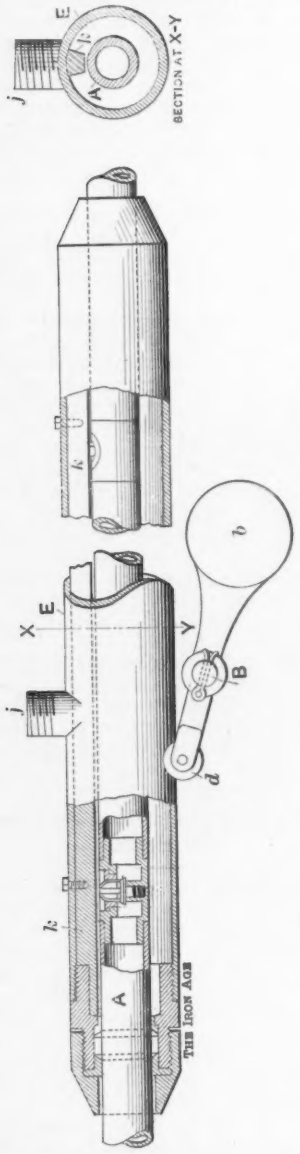


FIG. 1.—RECEIVER SLEEVE AS FITTED TO PIPE, SHOWING ITS METHOD OF RELEASING THE AIR.

In this case the air supply line for the crane or hoist is arranged in the form of a continuous pipe of suitable size running full length of the runway and supported freely at suitable intervals upon swinging brackets. The pipe is in short sections, connected by internal couplings, so that the outer surface of the pipe is smooth and practically continuous. Each of these internal couplings serves not only to join the adjacent short sections of the supply pipe, but is arranged to contain within itself a valve from which air may pass to the crane mechanism under the proper conditions, as will be described.

Referring to Figure 2, *A* is the air pipe running the full length of the runway and supported freely, as shown, by the counterweighted hanger *B*, carried upon a stud extending outward from any suitable support *C*, to which it is attached in a convenient and substantial manner. The hanger *B* is arranged to turn freely upon the stud, and is normally held in an upright position by the counterweighted lower end *b*. The upper end of the hanger is in the form of a saddle or yoke, each fork of which carries a small roller, *d*. In Figure 3 is shown the method of connecting two sections of the pipe *A* by means of the internal coupling *D*, in which is placed the valve *e*. The seat *f* in the valve *e* is screwed into place from the exterior of the pipe and, when removed, frees the valve also for removal upward through the hole. Extending upward from the face of the valve and protruding above the exterior of the pipe is the cage *h*, by means of which the valve is depressed to allow the air to pass outward. Under the stem of the valve is a helical spring, *i*, for holding the valve in place when the air pressure is off, and for returning it quickly to its seat when the crane moves away to other portions of the supply pipe.

From Figure 1 the operations of the whole device may be understood. Here *E* is a long shell or sleeve with conical ends, within which ends stuffing boxes are arranged to make tight joints between the sleeve ends and the exterior

of the pipe *A*, which the sleeve embraces and along which it moves. This sleeve is attached to the traveling crane or hoist, and moves with it at all times. From the outlet *j* pipe connections are led to the hoisting and traversing mechanism. At *B* is shown the swinging

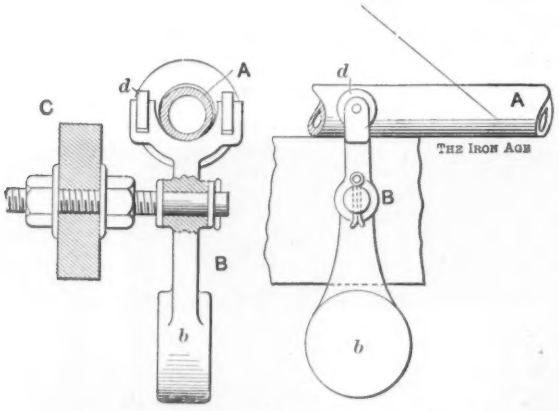


FIG. 2.—SWINGING BRACKET AND SUPPORT.

hanger of Figure 2, the conical end of the traveling sleeve having struck the small rollers *d* and deflected the hanger to one side. It will be understood that as the sleeve passes beyond and away from the successive hangers the latter return to their normal vertical positions to support

stuffing box at the advancing end of the sleeve successively depresses the valves *e* by striking the protruding cages *h* and forcing the valves downward against the air pressure and the springs *i*. As seen from the cross section at the right of Figure 1, the interior of the shell *E* between the stuffing boxes at the extreme ends carries a longitudinal rib, *k*, which holds the valve open during the time that the sleeve is above and covering it. Thus for any position of the crane throughout the length of the runway open connection is maintained between

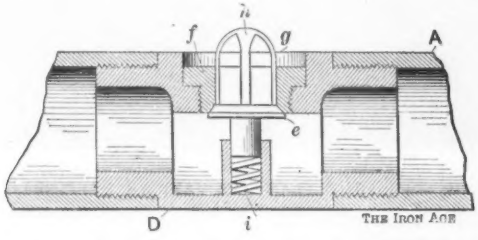


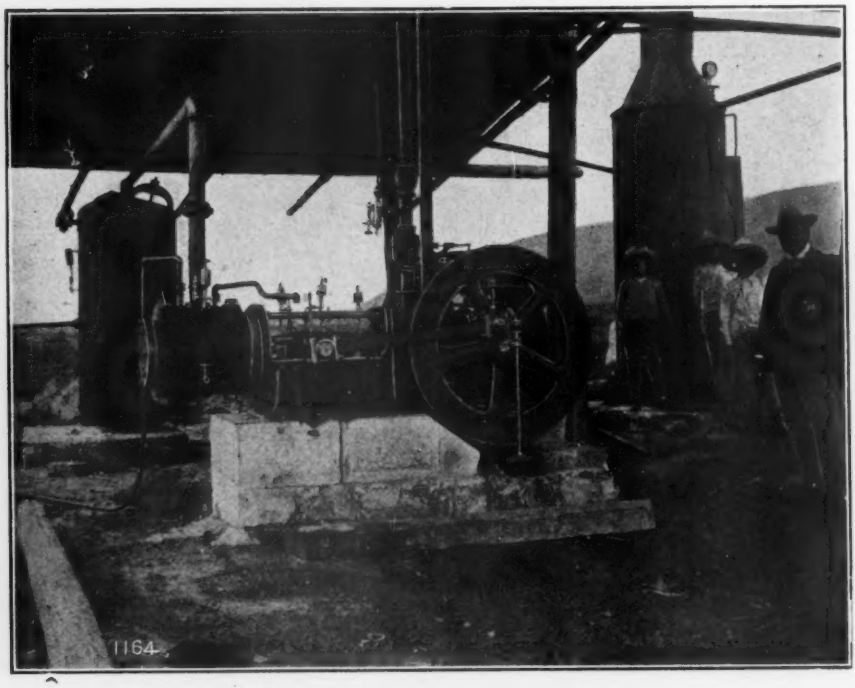
FIG. 3.—COMBINATION PIPE COUPLING AND AIR VALVE.

the pipe *A*. The length of the sleeve is enough greater than that of each section of the pipe *A* to enable it to include at all times within its interior at least one of the valves *e*, Figure 3. As the sleeve traverses the length of the pipe *A*, the interior of the air supply pipe and the hoisting and traveling mechanism through the valve *e* and the connection *j*.

The device is the invention of James L. Pilling, of the Pilling Air Engine Works, Bucyrus, Ohio.—*The Iron Age.*

The Air Lift Pump in Mexico.

A very good evidence of the utility of the air lift pump for irrigation purposes on farms and plantations is shown by the fact that it has been successfully introduced even in old Mexico, where the conditions are much less favorable than in this country, owing to the high cost of fuel, the greater cost of importing machinery and the scarcity of intelligent labor to operate it.



AIR COMPRESSOR PLANT AT MEXICAN HACIENDA.

We present two photographic views of an air lift plant recently installed in an Hacienda or plantation about 50 miles from the City of Mexico. A test run the day after air was turned into the well gave the following results:

Total depth of well, 126 meters = 413 feet.

Cased to 48 meters = 157 feet, with 7⅓ inch diameter pipe, balance to near the bottom cased with 6-inch inside diameter pipe.

Depth of water level when not pumping, 38 meters = 125 feet.

Depth of water level when pumping, 39 meters = 128 feet.

Lift above the surface, 2 meters = 6 feet.

Total lift, 41 meters = 134 feet.

Diameter of water discharge pipe, 3 inches.

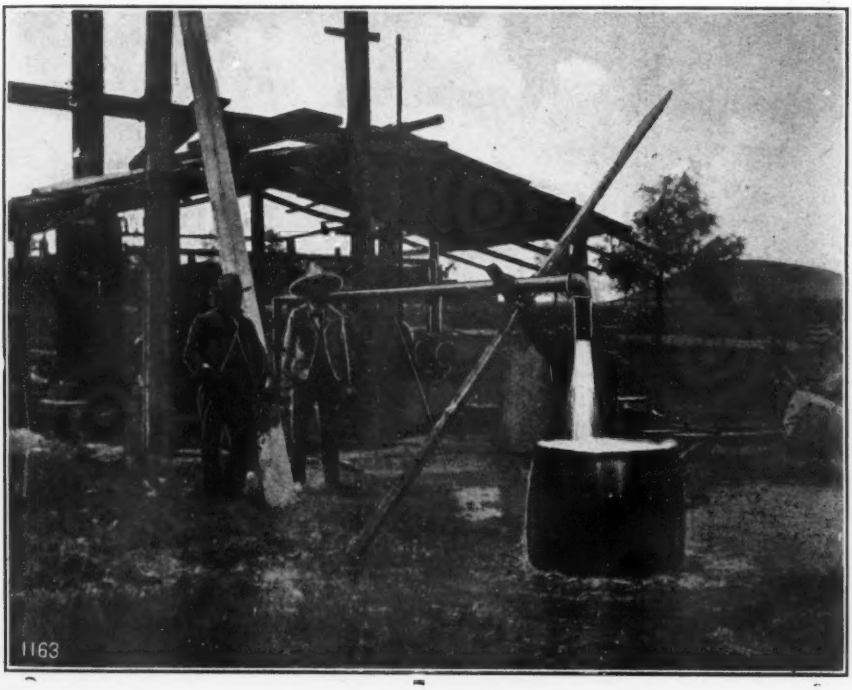
Diameter of air pipe, 1¼ inches.

Horizontal distance from well to tank, 3 meters = 10 feet.

Depth of air and water pipes below surface, 94 meters = 308 feet, equal 63 per cent. radio of submergence.

Quantity of water raised per minute, 400 litres = 105 gallons.

Air pressure when starting, 82½ pounds.
Working air pressure, 79 pounds.
Steam pressure at boiler, 80 pounds.
Altitude above sea level, about 7,000 feet.
Air compressor used, Ingersoll-Sergeant Class "F," steam and air cylinders, 10 by 10 inches; speed, 150 revolutions per minute; volumetric capacity at sea level, 134 cubic feet free air per minute, equal to 105 cubic feet when operated at 7,000 feet altitude.



AIR LIFT AT MEXICAN HACIENDA.

Air Motors and Air Hammers.*

APPARATUS AND METHODS FOR TESTING.

1. The apparatus and methods described below are those used in some extensive tests of air-drill motors and air hammers made by the Chicago, Burlington and Quincy Railroad Company in its laboratory at Aurora, Ill. The tests were made for the purpose of determining the air consumption, horse-power, stalling load of motors, number and force of hammer blows, etc.

* Presented by Max H. Wickhorst at the New York meeting, December, 1903, of the American Society of Mechanical Engineers.

GENERAL ARRANGEMENT.

2. The general arrangement of the apparatus is shown in Figure 1 and in photograph, Figure 2 (not shown).

The air used for making the tests was obtained from the shop supply, which was generally about 60 or 70 pounds. As we desired pressures varying from 60 to 120 pounds, we stepped up the pressures by pumping the air through a 9-inch Westinghouse pump which had the air cylinder bushed to a diameter of 7 inches. This bushing was necessary, as the steam pressure at the Laboratory is only about 60

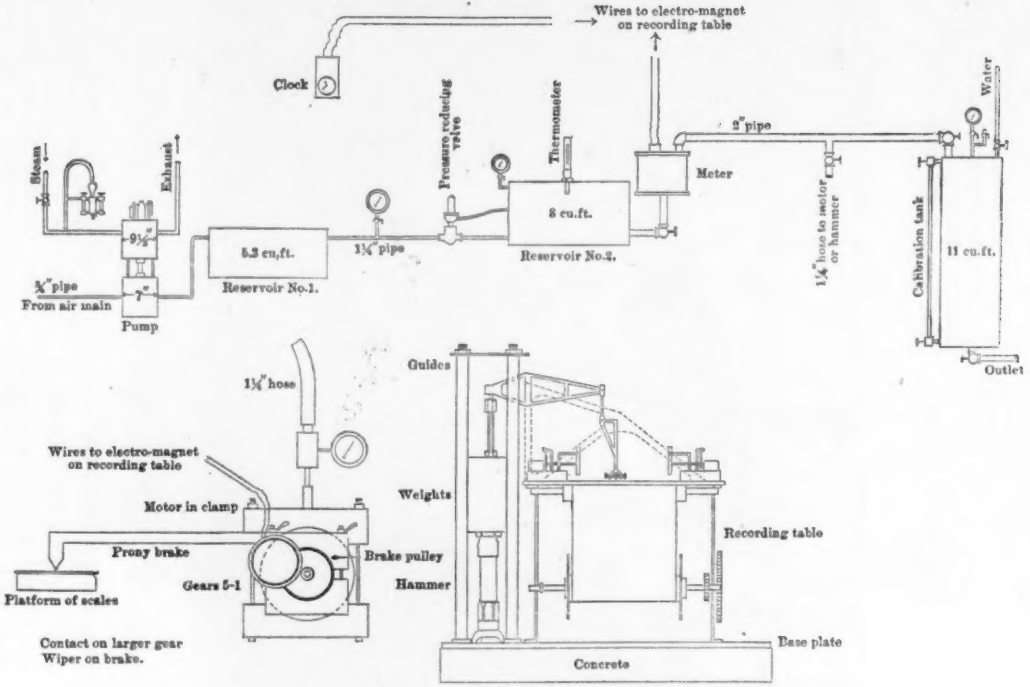

Wires to electro-magnet on recording table
Clock
Pressure reducing valve
Thermometer
Meter
2" pipe
Water
Steam
Exhaust
9½"
7"
¾" pipe
From air main
Pump
5.3 cu.ft.
Reservoir No.1.
1¼" pipe
8 cu.ft.
Reservoir No.2.
1¼" hose to motor or hammer
Calibration tank
11 cu.ft.
Outlet
1¼" hose
Wires to electro-magnet on recording table
Motor in clamp
Prony brake
Platform of scales
Gears 5-1
Brake pulley
Contact on larger gear
Wiper on brake.
Guides
Weights
Hammer
Recording table
Base plate
Concrete

FIG. 1.

pounds. The air was then pumped into reservoir No. 1, with ordinarily a pressure of 140 or 150 pounds. From here the air was allowed to flow into reservoir No. 2, where it was maintained at any pressure desired by means of a reducing valve, which was a regular 1-inch Westinghouse air-pump governor. An oil cup containing a thermometer was screwed into reservoir No. 2, and was used to determine the temperature of the air supplied to the tool.

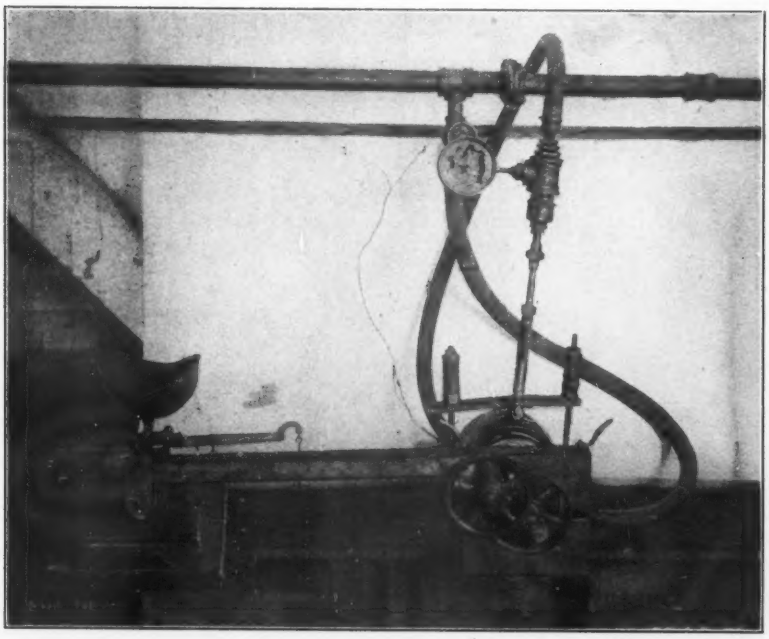


FIG. 3.

Another thermometer was also used to note room temperature.

3. From the reservoir No. 2 the air passed through a meter. This is a high-pressure meter made by the Equitable Meter Company, Pittsburg, Pa., and in construction is similar to an ordinary gas meter, the air alternately filling out and exhausting from leather bellows. From here the air was delivered to the tool to be tested, through a 2-inch pipe and 1¼-inch hose. At the point where the air was delivered to the tool we had an expansion consisting of a 2-inch Tee, with an internal diameter of about 2¼ inches, in which we determined the pressure by means of a gauge. Care was taken that between the point where the pressure readings were taken and the tool to be tested there was no contraction in the supply pipe smaller than the opening into the tool under test.

4. For the purpose of calibrating the air meter we used the tank as shown in Figure 1. This tank had a gauge glass its full length, and its cubic capacity was determined for each 5 inches on the glass by weighing the water.

5. The records of time, revolutions of motor, air consumed and strokes of hammer were obtained autographically, using the record table shown in Figure 1. The records were obtained on glazed manilla paper 14 inches wide, moving across the

table under electro-magnetic pens. The driving mechanism of the paper consisted of an air motor and suitable gearing. The electro-magnets actuated stylographic pens feeding red ink. One of the pens was actuated by a clock, making a contact every five seconds. Another was actuated by the air meter, a wiper making contact with the teeth of one of the gear wheels in the recording mechanism, and each contact up, thus allowing full pressure; the outlet valve was opened, the record paper started going, and as the water in the gauge glass passed the marks 5 inches apart, record was made by the observer pressing a push button. The meter at the same time made its own record, and thus we were able to figure out the number of cubic feet per contact or per notch. We also obtained record of 5-second intervals. As the read-

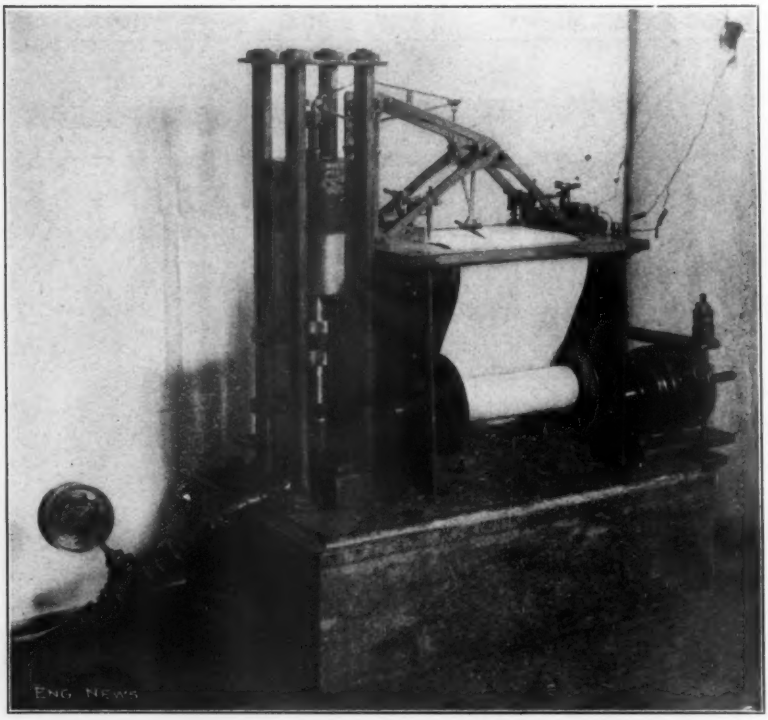


FIG. 5.

representing about ¼ cubic foot of air. The third pen was used to record the revolutions of the motors by arranging a wiper and a simple gearing, so as to make a contact every five revolutions of the socket for holding the drill.

6. In calibrating the meter the method was to have the calibration tank about full of water, the valve from the meter opened

ings of the meter varied somewhat with different rates of flow, calibrations were made at different rates by varying the opening at the outlet valve. A calibration curve was then made by plotting notches per minute as abscissæ and cubic feet per notch as ordinates. A number of calibration tests were made during the course of the tests of the tools.

TABLE I.

BURLINGTON ROUTE LABORATORY,
AURORA, ILL.
TEST OF AIR MOTORS,
1903.
Fac-simile Data Sheet.

Lab. No. 621.54 M 47.

AIR MOTOR TEST. Test 61.

MAKER: Air Tool Co. NAME OF TOOL: Mendota. SIZE: 3. TYPE: 3 Cyl.
WEIGHT: 47 Lbs. SERIAL NUMBER: 82. COST:

REMARKS:

BRAKE LEVER ARM: 3 ft.

DATE: 8/4-03. TEMPERATURE ATMOSPHERE: 87 deg.

	A	B	C	D	E	F	G	H	I
1. Press. reservoir.... ...	101	101	101	101	121	121	121	121	121
2. " at tool.....	100	100	100	100	120	120	120	120	120
3. Tempr. comp. air	101	102	102	103	106	108	110	112	114
4. Notches per min.....	24.	21.2	19.5	17.6	23.4	24.	20.	20.3	17.5
5. Cu. ft. per notch	.262	.264	.265	.266	.263	.262	.264	.264	.266
6. Cu. ft. C. A. min.....	6.8	5.6	5.2	4.7	6.2	6.8	5.3	5.4	4.6
7. Free air.....	52.	42.8	40.	36.	56.	61.3	48.	47.7	41.5
8. Rev. per min.....	138	119	89	72	135	115	91	88	78
9. Wt. on scale	20	25	30	35	25	30	35	40	45
10. Brake H. P.....	1.57	1.7	1.52	1.45	1.92	1.97	1.82	2.02	2.
11. Stalling weight.....	.....	.....	.....	37	.....	.....	.....	.....	48
12. "11" at one ft. radius.	.....	.....	.....	111	.....	.....	.....	.....	144
13. "Seven" per H. P.....	33	25	26	24.8	29	31	26.5	23.5	20.7

(Signed).....

Observer.

TABLE II.

Lab. No. 621.54 H 12
Test 501.

AIR HAMMER TEST.

MAKER: Air Tool Co. NAME OF TOOL: Vulcan. SIZE: 8.
WEIGHT: 22 lbs. SERIAL NUMBER: 3171. COST:
WT. PLUNGER: 1 lb. DIAM. CYLINDER: $1\frac{1}{16}$". STROKE INCHES: 8.

REMARKS:

DATE: 7/22-03. TEMPERATURE ATMOSPHERE: 87 deg.

	A	B	C	D	E	F	G	H	I
1. Press reservoir	60	80	100	120					
2. " at tool	60	80	100	120					
3. Temp. comp. air	88	90	90	91					
4. Notches per min	29	24	25	21					
5. Cu. ft. per notch	.271	.269	.27	.268					
6. Cu. ft. C. A. min	7.85	6.45	6.75	5.63					
7. Free air	39.2	40.8	51.6	50.6					
8. Strokes per min	834	892	964	1,000					
9. Weight	120	120	120	120					
10. Distance raised	.004'	.0052'	.006'	.0065'					
11. Ft. lbs. per blow	.48	.624	.72	.7818					
12. Horse-power	.0122	.0168	.021	.0236					
13. "Seven" per H. P	3,200	2,400	2,400	2,100					

(Signed).....
Observer.

BURLINGTON ROUTE LABORATORY,
AURORA, ILL.
TEST OF AIR HAMMERS,
1903.
Facsimile Data Sheet.

The various gauges used from which pressure readings were taken were previously checked up and adjusted by means of a Crosby Dead Weight Tester.

MOTOR TESTS AND CALCULATIONS.

7. The arrangement used for testing motors is also shown in Figure 1 and in the photograph, Figure 3. The arrangement was to apply the load by means of a Prony friction brake, the revolutions being recorded by means of a wiper making contact every five revolutions. The air consumption and time were recorded as described above.

8. The procedure was to first regulate the pressure in reservoir No. 2 at 60 pounds, then put on a light brake load, keeping this constant during the test with full open throttle. Another test was then made with heavier brake load with the same air pressure, and the increments of load continued in successive tests till the tool was stalled. Then air pressures of 80, 100 and 120 pounds were used in the same manner.

9. Table No. 1 shows a sample data sheet, and the various items and calculations were obtained as follows:

No. 1 and No. 2 are pressures as read by an observer on gauges and are pressures above atmospheric pressure.

No. 3 is temperature in degrees Fahrenheit of the compressed air in reservoir No. 2.

No. 4 is the meter contacts or notches obtained from the autographic record included in a strip of record covering one minute as recorded by the clock.

No. 5 is the cubic feet of compressed air per meter notch as obtained from the calibration chart.

No. 6 is the cubic feet of compressed air per minute obtained by multiplying Nos. 4 and 5.

No. 7 is the number of cubic feet of free air per minute obtained from No. 6 by the following formula:

$$FA = \frac{CA \times (P + 15)}{15}$$

where FA = free air in cubic feet per minute.
CA = compressed air in cubic feet per minute.
P = pounds gauge pressure at tool.

No. 8 is the revolutions per minute of socket for holding the drill and is obtained from the autographic record.

No. 9 is the brake load as shown by the weight on the scale at the end of the lever arm, usually 3 feet, except with the smaller motors, where the lever arm was 2 feet. This brake load was predetermined and kept constant by an observer during each test.

No. 10 is the brake horse-power, and was calculated as per following formula:

$$BHP = \frac{RPM \times 2r \times 3.1416 \times w}{33000}$$

where BHP = brake horse-power.
RPM = revolutions per minute of brake-wheel.
r = radius in feet of brake-lever.
w = weight in pounds on scale.

No. 11 is the load on scale, which was just sufficient to stall the tool.

No. 12 is the stalling load at 1 foot radius, calculated from No. 11.

No. 13 is the cubic feet of free air consumed per minute per horse-power, obtained by dividing No. 7 by No. 10.

10. After obtaining these various data we plotted three curve sheets to show up the results by the graphic method, representing in each case the air pressure as abscissæ. On one we plotted as ordinates the stalling load at 1 foot radius, on another the air consumption in cubic feet of free air per minute per horse-power at maximum horse-power, and on the other the maximum horse-power.

AIR HAMMER TESTS AND CALCULATIONS.

11. The arrangements for testing air hammers is also shown in Figure 1 and photograph, Figure 5. The method in general was to let the hammer strike upward against a known weight adjusted to the size of the hammer and to autographically record the distance the weight was lifted. The weights varied from about 40 to 150 pounds, and the vertical lift was multiplied 8 times on the record.

12. The results of test were recorded on a blank, copy of which is shown in Table II.

No. 1 and No. 2 are gauge-pressure readings as noted by an observer.

No. 3 is the temperature in degrees Fahrenheit of the compressed air in reservoir No. 2, as noted by an observer.

No. 4 is the meter contacts or notches per minute, as obtained from the autographic record.

No. 5 is the cubic feet of compressed air per notch, as obtained from the calibration chart.

No. 6 is the cubic feet of compressed air per minute, obtained by multiplying Nos. 4 and 5.

No. 7 is the cubic feet of free air per minute, obtained by the same formula as given under air motors.

No. 8 is the number of strokes per minute, obtained from the record by counting the strokes made in one minute.

No. 9 is the pounds of the weight placed over the hammer.

No. 10 is the average distance in feet the weight was raised, as obtained from the record.

No. 11 is the foot pounds of effective work per blow, obtained by multiplying the weight in pounds by the distance in feet it was raised.

No. 12 is the horse-power of the hammer, obtained as per following formula:

$$HP = \frac{\text{ft. lbs.} \times \text{blows per min.}}{33000}$$

No. 13 is the cubic feet of free air per minute per horse-power.

13. After obtaining the results of test, three curves were plotted from them as follows, in each case the pounds gauge pressure being plotted as abscissæ and the following as ordinates: foot pounds per blow, cubic feet of free air per minute per horse-power and horse-power.

14. In conclusion, the author desires to express his special thanks and acknowledgments to Mr. H. F. Wardwell, who did the greater part of the work in making the designs and tests.

Caisson Disease and a Safety Apparatus for Pneumatic Caisson Locks.

Within the last fifteen or twenty years the use of pneumatic pressure has been greatly extended in foundation work, tunnels and similar engineering undertakings, and has probably been more widely applied in this country than elsewhere. In New York City alone it has been applied in the construction of numerous foundations for tall buildings. The constantly increasing magnitude of the structures and the frequent necessity of locating them irrespective of foundation conditions, has required the work to be carried to greater and greater depths. This has involved the use of correspondingly heavier air pressures, which, in several instances, have exceeded ordinary limits and have caused sickness and death to the workmen. If the water has free access to the working chamber, the pneumatic pressure necessary to exclude it must, of course, equal the hydrostatic head, and amounts approximately to ½ pound per foot of depth from water level to cutting edge. In many cases, however, water is encountered only in veins, or where it percolates through soft material, and develops less pressure head, and, therefore, requires less pneumatic pressure to exclude it.

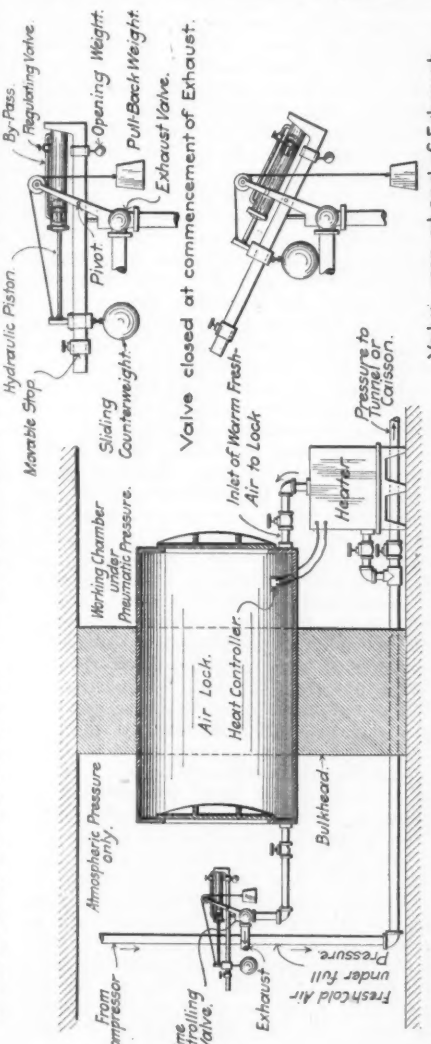
Pneumatic caissons have not been adopted for the foundations of buildings, except in New York, and there they seldom require a pressure much above 20 pounds per square inch. Many bridge piers have been built with similar pressures, but in some cases they have required pressures of nearly 50 pounds; in other cases bridge piers and tunnels have been so deep that the full theoretical pressure would have been much greater than 50 pounds, which has so far been accepted as about the practical limit. The safety and certainty of constructing work under pneumatic pressure is often an inducement to carry it as deep as possible by this method and use the highest permissible pressure. In these cases the utmost precautions have usually failed to entirely prevent injury to the workmen, and it is important to thoroughly understand the effect of the pressure on the human system and to make every provision which can prevent or alleviate injurious results.

The deepest pneumatic work in New York was done in the East river gas tunnel at a maximum of about 114 feet below high tide, and in the foundations for the Williamsburg bridge towers 107.5 feet below high tide, where the maximum pressures were respectively about 50 and 47 pounds per square inch above atmospheric. In the gas tunnel four men died through the effects of the heavy pressure, while none died from that reason on the bridge work. The foundations for the new Manhattan bridge between New York and Brooklyn have been carried to a depth of 92 feet with a pneumatic pressure of 45 pounds, from the effects of which five men have so far died. Heavy pressure has been used in the North river tunnel from Jersey City, and will probably be used in the proposed Pennsylvania tunnels across the North and East rivers. Moderate pres-

sure is also being used in the Rapid Transit tunnel from the Battery to Brooklyn, and may there be increased to a maximum of about 45 pounds.

Ordinarily, strong young men in proper condition do not suffer from working two four-hour shifts daily under pressures up to 25 or 30 pounds. Above that limit injurious effects may be felt, and the length of the shifts is usually decreased to a minimum of about 45 minutes under maximum pressures. For work in heavy pressure the men are subjected to a careful medical examination and only comparatively young and strong men with a good heart action are selected. They are required to avoid dissipation, and precautions are taken to make them emerge slowly from the pressure and remain for some time afterward in a very hot room, where they are served with strong coffee and are given a long interval of rest between shifts. The wages are increased in inverse proportion to the length of the shift. (In the Williamsburg bridge caissons the men received a maximum rate of $3.75 for working one and a half hours, in two 45-minute shifts daily). This, together with the short working hours, gives so much opportunity for dissipation that many of the men abuse themselves with drink and in other ways. To this and to carelessness in emerging too rapidly from pressure nearly or quite all of their injuries from pneumatic pressure are attributed by their employers. No injurious effects are known to result from very rapid entrance into compressed air, although it sometimes produces temporary headache, and slight discomfort is always occasioned in maintaining equilibrium between the air pressures inside and outside the body. This is principally felt in the ears, where it is overcome by repeated efforts of the lungs to expel the air while the mouth and nostrils are closed. Most persons after remaining two or three hours in a pressure of 30 pounds or more feel an itching, pricking sensation under the skin on all parts of the body when they emerge from the pressure. This disappears in a few minutes and causes no further trouble.

No disagreeable or injurious effects are observed while a person is under pneumatic pressure, but after emerging from pressure above 30 pounds some individuals are subject to the "bends," which is the popular term for severe pains like rheumatism, which attack one or more of the joints and may last for any time up to twenty-four hours. Sometimes they are very violent and cause the patient to double up as if with cramps, but it is not recorded that they are ever fatal, and when once they have ceased no further results are felt. The treatment prescribed for



REGULATING VALVE AND HEATING APPARATUS ON PNEUMATIC PRESSURE LOCK.
THE ENGINEERING RECORD.

them is hot baths, perspiration, re-entering the pressure and emerging from it very slowly. The same remedies are also efficient for the itching sensation.

The most serious effect of pneumatic pressure is paralysis, which usually attacks the legs and lower part of the body, and may extend further and become fatal. It occurs within an hour after leaving the pressure, and generally within ten or fifteen minutes. Patients suffering from it are subjected to the ordinary hospital treatment for paralysis. From 2 to 3 per cent. of the men employed under a pressure of 40 pounds are likely to suffer from the "bends," and generally return to work in a day or two after the pain ceases. Less than 1 per cent. of them become paralyzed. It is not recorded that workmen who have suffered from the "bends" have also suffered from paralysis. Paralysis usually occurs without any warning whatever, and it is believed by the men that a little discomfort from the "bends" is desirable as a safeguard against paralysis.

When a man is threatened with bad results from the pressure they can generally be averted if he can return to the pressure before the trouble has developed and remains in it until it is very gradually released. It is believed that forty minutes should be taken to emerge from a pressure of 40 pounds above the normal, and in general, that the time should be one minute for each pound, care being taken to reduce the pressure with great regularity. Ordinarily, however, the time really so occupied is not much more than one-tenth of this. If this rule were rigidly observed and all the workmen were subjected to a rigid medical examination before entering the pressure, and were prevented from indulging in excesses, it is believed that there would be few or no casualties due to the effects of the pressure, even when much higher than is now customary.

Eminent German and French physicians and scientists have studied the effects of pneumatic pressure by numerous experiments on men and animals, and their general conclusion is that the bad results are due to the compressed air forced through the lungs into the blood, being liberated there by too rapid diminution of the pressure. One experimenter subjected a great number of dogs, cats, rabbits, guinea pigs and other animals to repeated pressures up to 100 pounds, and carefully observed the effects of varying conditions, some of which were fatal and others apparently harmless. He devised means to bleed the animals while under pressure; afterward the blood was removed, and when it was released from pressure threw off gas, which was collected, analyzed and found to be nitrogen. The experiments showed that sudden release from heavy pressures was fatal, but that if three or four hours were occupied in reducing a pressure of 100 pounds, it was harmless.

The generally accepted theory deduced from these experiments and other observations is that, under a pressure of more than 30 pounds, a considerable excess of air is absorbed in the blood, but can pass off harmlessly if the pressure be very slowly and regularly reduced. If the pressure is quickly reduced, the air does not have time to escape safely and naturally, but is, instead, resolved into its elementary constituents; the carbonic acid is thrown off in the usual way by the lungs, the oxygen is absorbed in the tissues, and the nitrogen is liberated and effervesces in the form of very minute globules. These globules of nitrogen are forced with difficulty through the capillaries and produce the itching and pricking sensation always experienced after heavy compression. If these globules are too numerous to be absorbed, they combine in larger bubbles, which reach the heart and produce embolism, interfering with its action, and when driven through the arteries and veins produce paralysis or collect in the joints, causing the "bends." The same effects have been produced by injecting nitrogen gas into the veins of animals. Thus paralysis similar to that of the caisson disease has been induced without placing the subjects under pneumatic pressure at all.

The obvious way to prevent "bends" and paralysis from pneumatic pressure is to insure a sufficiently slow and regular reduction of the pressure. As the locks in which the men emerge from the working pressure are usually very small and are likely to be crowded full, the air would soon become vitiated if the occupants were obliged to remain, as they should, for half an hour or more in emerging from a heavy pressure. Besides this, the reduction of the pressure causes a corresponding fall of the temperature, making the interior of the lock very uncomfortable. To avoid these troubles a safety apparatus has been invented and patented by Mr. W. I.

Aims, engineer of the gas tunnel which was built under the East river several years ago, and described in *The Engineering Record* of March 10, 1894.

This new safety device has two parts. One part is an apparatus for heating and forcing a constant supply of fresh air into the lock to keep the atmosphere very warm and pure during the time that the pressure is being reduced. The other part is a locked device for regulating the outlet which reduces the air pressure in such a manner that the rapidity of exhaust is beyond the control of the men in the lock, who are very liable to hasten it without regard to safety. The essential features of the apparatus are shown in the accompanying diagram. The fresh air is forced by a compressor through a heating apparatus controlled from within the lock. The exhaust from the lock escapes through a pipe and special valve that is commanded by a counterweighted lever. The lever rests on top of the valve stem and forces it downward, tending to close the valve. It is pivoted horizontally to a bracket a short distance from the valve stem and is counterweighted on both sides of the latter. The principal counterweight is on the long arm of the lever beyond the valve stem, and when this arm rises, the valve stem is forced upward by the pressure of the air in the lock and allows it to escape in proportion to the movement of the lever. The counterweights are proportioned and adjusted so that when the large one engages a stop near the end of the long arm it will just close the valve against the initial lock pressure. The smaller weight is set on the short arm so that when the large weight is moved near the fulcrum its moment will revolve the lever into an inclined position and allow the valve stem to rise and completely open the valve. The large weight slides freely on the lever and is pulled toward the valve stem and fulcrum by a counterweight. Its motion in this direction is resisted by a balanced hydraulic piston, which moves in a cylinder having both ends connected by a bypass commanded by a regulating valve. This valve can be set so as to allow the piston to move at any rate of speed under the force exerted by the suspended weight. This regulates the valve and the latter gradually opens at any required speed and allows the air to escape from the lock in any given time. This apparatus is beyond the control of the men and makes it impossible for them to tamper with the exhaust. It maintains a regular diminution of pressure regardless of the amount of fresh air introduced into the lock, and therefore enables the warming and ventilation to be conducted independently of the exhaust.

A modification of this system is effected by placing the time-control valve on the fresh air inlet pipe and starting the latter under full pressure when the lock doors are closed. The exhaust outlet, which is proportioned to correspond with the maximum pressure, is then fully opened and permits a constant discharge, while the supply of air is gradually diminished, thus eventually securing the complete and regular reduction of pressure in a given time. This method is less desirable than the first, because it limits the quantity of fresh air. If the locks have no other valves under the control of the workmen, they cannot hasten the operation or emerge too soon, because it is impossible for them to open the exit door until the pressure is completely exhausted.

Mr. Aims is the engineer for the New York Tunnel Company, Mr. Andrew Onderdonk, contractor, which is building the New York Rapid Transit Tunnel from the Battery to Brooklyn. The pressure on that work is now 10 pounds and may eventually rise to 45 pounds. When it reaches 25 or 30 pounds Mr. Aims intends to apply the above-described apparatus to the locks.—*The Engineering Record.*

Air Lift Pumps.

The air lift or Pohlé pump is attracting a good deal of attention just now. The *Berg und Huttenmannischen Zeitung*, Jahrgang 1903, No. 11, contains a special article on "The Application of Compressed Air to the Raising of Water," by L. Darapsky. A large portion of the article is devoted to the consideration of the claims of rival patentees and decisions in the German law courts with which we are not concerned. We reproduce here extracts from Herr Darapsky's paper, which will be found to supply a good deal of information concerning the history and progress of the air lift system. We find it impossible, in making the translation, to get rid of the somewhat lumbering style of the original.

Fundamental inventions seldom lend themselves to protection by patent. If their principle may be traced to Nature, their very generality prevents the clear outlining of a claim which refers clearly to certain methods of improvement of a definite nature. As, however, the latter only can be patented as far as they are technically worth anything, it is very seldom indeed that real original ideas adapt themselves to this. Even their most tempting realizations become soon outstripped, and more often and more easily circumvented. Such so-called inventions are so much the more likely to end in smoke as soon as a comparatively little explored domain receives closer attention. Most of the modifications which lead in the same direction look, from a distance, so much alike that the one can scarcely be distinguished from the other. Then, also, it is not so much the original idea which proves the chief success, but the more or less lucky formula and stipulations which, far beyond their meaning, become in the hands of an expert either a weapon or a scarecrow. A glance at the present position of inventions for raising liquids, and water in particular, by means of compressed air, confirms this experience. In this article we will only deal with such machinery, by means of which water may be raised, without any mechanism, but simply by compressed air, and such exclusively through its lifting power, without the assistance of a *vis a tergo*. An example of this may be found in the beads which detach themselves at the bottom of a glass of champagne, but, as in this case apparently no work is done, a better example would be the raising of water in the discharge tube of a gasogene, under the influence of rising gas bubbles. The action is here, according to its nature, really different from that which is exercised by the air, by means of its pressure or its velocity, or, when the two are combined, by its force.

The latter came to the front through the jet pumps—injectors, ejectors, also briefly called elevators—which in the two last decades have been brought to extraordinary perfection. It is merely by overpressure that the air-works in juice lifts—montejus—for acids, etc., and also in syphons and in the drawing of beer—with carbonic acid; compressed air lifts have even been applied to hose-pipes, extinguishers, and feed pumps. The pulsometer is worked in a similar way by steam.

However, contrivances which are controlled by pressure or impact—usually intermittent—will not be discussed here, and we will simply confine ourselves to the practically useful effect of an air current, which, instead of entering the water from the top, as in the case of all the before-mentioned pressure apparata, enters from the bottom, and draws the material upward solely by reason of its expansion and its velocity, which increases during the ascent.

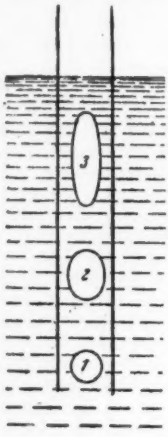


FIG. 1.

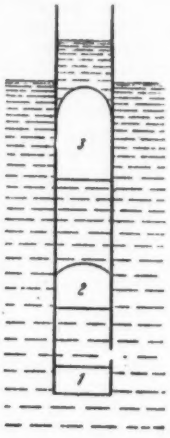


FIG. 2.

Perhaps it may not be superfluous to explain clearly the principle on which its action is based. Supposing that a pipe, which is open at both ends, is placed vertically in a vessel of water, then it will be found that the water level is the same both inside and outside. However, as soon as an air-bubble enters the bottom of the pipe—see Fig. 1—a difference will be noticed. First the bubble will rise through its own buoyancy; at the same time, in proportion as it rises, its volume augments, and it will even occasionally break up into other bubbles. From the sphere 1 emanates a somewhat elongated form 2, and higher up the spindle 3 is formed.

As long as the bubble remains isolated and does not entirely fill the pipe no further change will be seen in the water

level, except, at the most, an occasional oscillation. On the other hand, when the bubble occupies the full width of the pipe—see Fig. 2—and when it is large enough to reach the walls in the second and third state it will push the water before it like a layer, and will raise the isolated parts of the water column more or less in accordance with the speed acquired in the course of the ascent. Thus, all that is required is to admit the air constantly at the bottom, and to allow the water, which is being pressed upward, to discharge regularly, and the compressed air pump—see Fig. 3—is formed. According to the laws of communicating pipes, the aggregate weight of the water and air strata inside the pipes is equal to the pressure of the water outside, which is supposed to be unchanged. The level in the pipe is therefore obviously so much higher the more air there is injected. As a result of its expansion during the ascent, it will work with accelerating action on the water column, which it raises, and at the same time it will cause a suction on the water that follows it. The initial tension of the air should be sufficient to counterbalance the pressure for the actual depth of the water at the injection point. A starting velocity is not required. The upward impact takes care of the rest, and becomes only practically affected by loss through friction, surface tension, and eddy formation. One feels inclined to define such a contrivance as a mixed air lift, in contradistinction to the above-mentioned compressed air lift. In fact, this distinction is made in many descriptions, but it is nevertheless hardly to be recommended—first, because, in the case of proper injectors, air, water, and steam may also be thoroughly mixed together; secondly, because the mixing of air and water by the method under discussion should be strictly avoided, because the upward pressure develops more energetically the more the air pursues its course, in layers or masses, free from internal divisions. It would be more to the point to make a clear distinction between lift, or emersion, pumps and compressed air lifts, as the raising power of the air, together with its inherent expansion here, only becomes realized.

To define the present position of the technical application of this principle is the task which we now take in hand. This is necessary, because very commonly the erroneous idea is entertained that the so-called mammoth pump is a special invention, and that in it a monopoly of the benefits of the system has been established. That water can be discharged steadily at a considerable height by the simple means of mixture or injection of air can be observed in Nature, in the case of geysers, petroleum springs, carbonic acid pumps, and hot water springs, but remained for a long time unnoticed. It is quite true that as far back as 1797 the Freiberger Surveyor of Mines, Carl Emanuel Löscher, described an aërostatic engine to raise

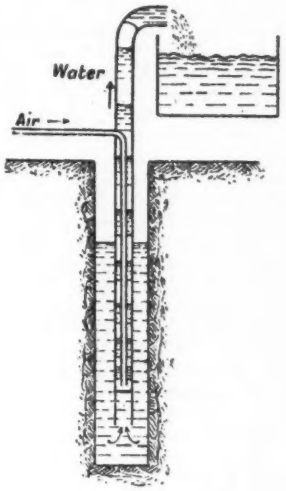


FIG. 3.

water some 100 yards. But his experiment did not meet with immediate recognition.

It was not until half a century later that the same idea was carried out in the American oil fields, obviously in a completely independent manner, brought about by the raising power of natural gases on the petroleum.

In the United States this question has also greatly come to the front since the beginning of 1890, partly in connection with the preference shown for the various applications for which compressed air can be profitably used, either on a large or a small scale.

Only since then has this method found its way back to France and Germany. As late as 1885 a man of such original ideas as Werner Siemens found reason to complain of the want of comprehension when he drained a strata of brown coal, near Berlin, in the manner described, and when he erected another contrivance in his factory, which discharged as much as 700 litres of water per minute.

However, it had been already suggested, in 1876, in Wilhelmshaven, to increase the productiveness of two deep springs by means of compressed air, as in the American petroleum springs. Both borings, of 150 mm. and 360 mm. internal diameter, and 190 m. and 270 m. depth respectively, were able, by means of suction pumps, to supply barely 108 cubic metres daily, whilst the expense was estimated at M. 480,000. Nothing came of this but a discussion of "Preisswerk's scheme," when a great deal of thought was brought to bear upon the possibility as to whether, on the whole, there would be an increased volume of water when this, by the addition of air, became specifically lighter; and whether, if so, the filtration would not suffer by it. Even the idea propounded by M. E. Bourgeois and P. Doudart, in 1882, to assist the raising of fluids by admitting air into the discharge pipe, did not meet with approval. In this case valves were, of course, not entirely indispensable.

The most essential part of the system is, however, the absence of all valves, pistons, and other similar movable parts. The air enters the water through a pipe at a certain depth, and as it freely rises, leads the water upward through a second pipe. So much for the exterior arrangement, which is made clear by means of the sketch—Fig. 3. Not quite so apparent is the method of working. Many people think that the upward motion should yield more abundantly the smaller the division of the air in the rising water column, and the more perfectly the latter is permeated with small bubbles.

That the more intimate the mixture is the smaller the immersion depth may become is an opinion which was lately expressed in one of our periodicals. Various patented arrangements have undertaken the task of making the mixing as perfect as possible, or to produce, by means of special mixture holes, an ejecting action. The same conception is also the basis of the well-known Austrian patent of Gottlieb Hess, 4,312,457 (1893). That by such diffusion the loss of friction will be found to be smaller than in large bubbles was already shown by Siemens' experiment. The weight of the mixture contained in the discharge pipe, borne by the outer water column, decreases, of course, with the quantity of air and so favors the height of ascent. The aggregate weight, however, remains the same, whether the air divides the water columns into small particles or into separate layers. That by means of the latter method alone a good action can be secured is, however, one of the fundamental facts in connection with the proper use of the pump which may be easily proved.

A great deal of doubt still remains as to the conditions required to attain the highest efficiency. Individual points have been cleared up, step by step, as may be gathered from the numerous American patent specifications. The foundation of all the various modifications of air injection and water admission which hinges on this single problem in most claims is certainly not always free from objections. Thus, it was pointed out as early as 1865, by Robert McGrath—American patent 47,654—that if one wanted to use the well pipe for discharging purposes it would be necessary to place alongside of it an air pipe, and to give this "at the bottom a circular form in the well pipe, but, however, not so thick that it could interfere with the rising of the oil in the well pipe." The air would then flow upward through the annular pipe, which was to be provided with numerous little holes, and would raise the oil with it. Abel Brear—American patent 47,793—described in the same year—1865—as an ejector a contrivance of his in which an air pipe encased the rising pipe like a mantle, and was bent in the form of a hook at the bottom, in order to discharge centrally, while the liquid was admitted annularly. Joseph P. Frizell—American patent 233,499—returned in 1880, to McGrath's contrivance, but gave to the annular air orifice at the bottom an hour-glass section, the upper part being perforated, and joined to the rising main. The lower part widened out somewhat, and was in-

tended to facilitate the flow of the water. The air pipe itself lay free in the spring, detached from the rising main. Samuel S. Fertig, also, in 1884, attached great importance to the circular or annular supply of the air, and he did not hesitate, at the same time, to make the rising main narrower—American patent 309,214.

The most important improvement, however, was undoubtedly that of Julius G. Pohlé—American patent 487,639—in 1892, according to which, as a result of the action of the air in driving the water up, the rising main creates a suction at the same time. It is stated therein: "I have discovered that when air of adequate pressure, in sufficient volume, enters the bottom of a rising main discharge pipe, immersed in water, whilst the top of this pipe projects just so high above the water-level that the compressed air will force its superimposed water column up as an undivided mass, and that, of course, at the same pressure which is due to the head of water outside, alternate layers of air and water begin to be formed. These regular layers of air between the water increase the height of the aggregate water and air column, and thus facilitate the discharge at the top, which without the introduction of air layers would have been impossible."

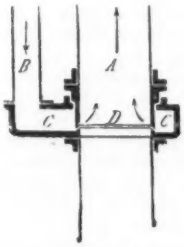


FIG. 4.

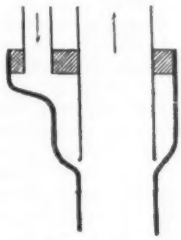


FIG. 5.

Pohlé gives then a sketch and precise dimensions of those various air and water blocks, the former of which, according to the laws of hydrostatics, become more elongated when they are higher up the tube. For the admission of the air, which enters through a peculiarly bent pipe, the opening of the rising main, he says, will have to be enlarged, "not only to compensate for the cross-section taken up by the air pipe, but also to ensure the formation of sufficiently large bubbles for the formation of air cushions." By means of the definition given above, the compressed air lift has grown from an "ejector" into a simple "elevator." As will be seen, the only similarity which remains with the injector is that, in the case of a rapid air current, its energy can also assist; hence the air supply will follow the direction of motion of the water. On the other hand, the air-lift pump is in so far similar to the hydraulic ram and pulsometer that in both the air acts directly upon the water.

For all that, the difference between the three systems is unmistakable. Unfortunately, the inventor died prematurely, and also his collaborator, Alexander E. Schnee; but the Pohlé air lift pump gave the key to the principle, which was for the first time clearly understood.

More than half a dozen designs were patented by Grumbacher at the end of 1894 and beginning of 1895 to exhaust different possibilities. Naturally, the struggle for improvement turned toward a series of considerations, which certainly all in practice—even almost without proof—were considered to be of importance, or, at least, without further investigation by the patent officials, were regarded as such; considerations, however, which are of little importance for the purpose of a closer inquiry into the proper precedents. Among them may be classified the division of compressed air in water by means of special spray holes—George J. Kennedy, No. 568,445, 1896—in contradistinction to Pohlé's rule, "that the air should freely escape, either in masses or as a whole, to prevent the formation of separate air bubbles." Further, the arrangement of sundry air admitters, the one upon another —J. E. Bacon, No. 542,622, 1895—and the opening and closing, and also the interchanging between them—J. E. Bacon, No. 542,620, 1895; and Silas W. Titus' patent, No. 566,102, 1896. The latter patent was turned to good account by the Pneumatic Engineering Company, of New York. The well pipe is also often used as a rising main, which is a rather doubtful proceeding from a practical point of view. For it happened that a pipe which was alternately filled with air and water, after three months showed a decrease in weight due to oxidization of

from 5.08 kilogrammes to 3.74 kilogrammes.

The supply of the liquids which have to be raised, and the manner of their conveyance, which undoubtedly influence the desired useful effect, were almost entirely neglected; indeed, these considerations have often been completely set aside by the inventors.

Mathematical proofs are generally altogether wanting. In France the development took a different shape. For the raising of sulphuric acids a similar contrivance to that of Siemens was used by Laurent in 1885, which he called an "emulsor." But Ch. Laurent soon preferred again direct-pressure apparata for this object, as made by Kestner, of Lille. Lambeaux used suction, obtained by the condensation of steam, as was done later in England in 1892 by G. W. A. Kahlbaum—English patent 7240—and J. Mactear—English patent 22,176. For a totally different application compressed air was made use of in a thoroughly independent manner by Henry Jandin, of Lyons, who, at the Exhibition for Public Works, in Paris, in 1885 to 1886, exhibited a compressed air dredger and mortar hopper, which had already done good service in the construction of the foundations for the piers of a bridge across the Guadalquivir, near Palma del Rio. In it the compressed air was used in a branch pipe to break up the bed of the river, while the hauling up of the material was the aim of the combination. The main point, according to the German report, is that the apparatus consists of a large iron pipe *A*, to discharge the dredging material, and a smaller pipe *B*, through which the compressed air is conducted to an annular mantle *C*, which encircles the bottom end of pipe *A*, from which it passes through the slit *D*, into the pipe *A*—see Fig. 4. This contrivance is distinguished from Giffard's injector and analogous sand-pumps—according to the reporter, M. Strukel—by the fact that in the latter the discharge pipe becomes narrower at the admission end, which is not the case with Jandin's. The slit *D*, moreover, is adjustable, or composed of numerous little holes. The air supply, however, always follows the direction of the discharge, from the bottom to the top. This dredging machine was tried at Saumur, on the Loire, in a sandy bed, and in Havre in a muddy bed, at a depth of 4 m. and 9 m. respectively.

At Lyons, during the building of a bridge, a piece of chain, weighing 50 kilos., was in this manner brought up. A dredging machine, intended for the harbor of Uleaborg, in Finland, was at that time at work on the river Saône, and this machine conveyed the dredged material, by means of compressed air, to a distance of 350 m. This pneumatic dredging did not meet with much approbation at first in Germany. Following the example of Hoech, perference was given to rotary pumps.

The application of compressed air for shaft sinking after the method of Jandin has certainly proved to be valuable.

Whilst in America, as early as 1895, it was pointed out by the *Sanitary Plumber* that it was well known that water could be raised to any desired height without the use of any moving parts in the well, it is to the credit of the engine works of A. Borsig, of Berlin, that with their financial support the raising of water by means of compressed air has come into prominence in Germany.

Of the various patents which Grumbacher interested himself in, we will only mention here the one taken out by Paul Schulz, November 2, 1895, No. 89,417, as the others are only definite applications of the same principles. This particular arrangement became of some importance by the fact that Borsig entrusted Professor Josse, of the Technical University in Charlottenburg, with the proof of its superiority over the so-called well pipe pump. The results of this test are published in the "Journal" of the Institute of German Engineers, xlii., 1898.

Professor Josse attributes the superiority of the Borsig bottom piece, as compared with the air pipe, which is bent into the rising main, to the admission of air around the whole circumference, by means of which the water contained in the ascent pipe becomes permeated with air bubbles. The real reason for the lesser efficiency of the bent air pipe is the contraction of the water entrance, and the thereby increased friction. Pohlé knew how to prevent this by widening the bottom of the ascent pipe.

A comparison between Borsig's footpiece—Fig. 5—and Jandin's "dredgerhead" shows perfect agreement, but for the direction of the air supply, which in Jandin's coincides with the rising current, but in Borsig's is admitted in the opposite direction.—*The Engineer* (Eng.).

Caisson Disease.

Five cases of trouble in consequence of working in compressed air in a bridge caisson have been reported in this city within the last few months. In one of these it is possible that a previously existing weakness of the heart may have been chiefly instrumental in producing the observed effects, but the others were doubtless caisson disease, or diver's palsy. pure and simple. The disorder has long been recognized by the medical profession. It is not of frequent occurrence, fortunately, because only a limited number of engineers and workmen are engaged in the actual operations of driving a tunnel. Still, a singularly large proportion of these suffer to a greater or less degree. Out of sixty-four men employed in a caisson on the banks of the L——— in 1884, sixteen had severe attacks, and it was necessary to discharge twenty-five on account of sickness. Two cases resulted fatally. Very often, when life is not lost, the ensuing paralysis is permanent. Such was the penalty paid by Washington Roebling for his devotion to duty in the construction of the first bridge over the East River.

Several theories have been advanced to account for this curious malady. It has been suggested that the seat of the mischief may be the brain and spinal cord, to which the blood is driven by increased external atmospheric pressure. Inasmuch as these parts of the body are inclosed in rigid walls, they cannot yield to distending influences, as the heart or other organs can. Other investigators imagine that the trouble results from an effervescence of air or other gases in the blood and soft tissues. Paul Bert advanced this idea some thirty years ago, and confidence in its correctness was expressed only a few weeks ago in *The Journal of Hygiene*, by Dr. Leonard Hill, of London, and Professor J. J. R. MacLeod, of Western Reserve University, who have recently co-operated in experiments of their own. To the lay mind the second explanation will doubtless seem the more satisfactory of the two, because the more serious symptoms usually develop not while the subject is under pressure, but after he is liberated. The unpleasant sensations felt in the ears and the temporary deafness when first confined are, of course, practically harmless. It is when the compressed air with which the whole system has become saturated (like a bottle of soda water, charged with carbonic acid gas), has a chance to expand that the gravest consequences are noticed.

A number of precautions are suggested in *The Journal of Hygiene* article. The selection of men not over twenty or twenty-five years of age, tough and wiry in their build and abstemious in their habits, is recommended. Before they are permitted to go on duty they should be tested with light pressures and rejected if they feel any ill effects. Unduly sensitive subjects having thus been weeded out, the utmost attention should be given to one other safeguard. After men who are about to begin work have entered the "air lock," that is always interposed between the outside atmosphere and the chamber in which excavation is carried on, the necessary increase of pressure may go on rapidly. Ten or fifteen minutes will usually suffice. When the men are coming out they should be detained in the ante-chamber much longer. "Decompression" should be more gradual than compression. Even when the pressure under which they have been working is not over thirty pounds to the inch, it might be wise to take from half an hour to an hour for the reduction. For higher pressures "decompression" should be still more protracted.

The amount of pressure in a caisson or tunnel depends upon the depth of the latter below the surface of the water. The fluid is excluded by the air. Dr. Hill and Professor MacLeod think that it will prove practicable to go fully two hundred feet below water level, and to use air pressures of more than one hundred pounds to the square inch, if picked men are employed and if two hours are devoted to the liberating stage. Such an assurance is gratifying, because no one knows exactly how far down it is safe to go in engineering operations of this class. Depths never before reached may possibly be attempted in the near future. The most immediate bearing of the paper here quoted, though, is upon enterprises now in progress. It reveals the importance of taking ample time for the release of men who are to-day working in compressed air chambers.—The *New York Tribune*.

High Pressure Gas Distribution by Gas Power.

A gas power installation of exceptional interest is now under construction by the Laclede Gas Light Company, of St. Louis, Mo. The system has for its object more efficient distribution of gas over larger areas than may be economically covered by the simple method of running large low-pressure mains from a centrally located gas generating plant to supply all parts of the city. The system under construction is intended to supply the entire city of St. Louis, embracing an area of approximately 65 square miles.

It is evident that in order to serve the outlying districts of such an area, one of three methods must be employed: First, large low-pressure feeder from central holder to center of district to be covered; second, medium sized feeders from main holder to auxiliary holder in center of district; and third, high-pressure feeder to distributing center, using pressure reducing valves at this point for obtaining proper pressure upon the service lines. The enormous expense for construction entailed by the first two methods has practically prohibited their use in St. Louis, and the high-pressure system is being installed. With this system, the size of feeder pipes is greatly reduced and the necessity of auxiliary district holders is entirely done away with.

For serving suburban communities, lying far beyond the city limits, this method may be extended and the pressure of the gas raised to any desirable extent for transmission through small pipes, this pressure being reduced at the suburban distributing center by pressure regulators, as in the medium pressure system above mentioned.

This gas distribution system as a whole presents a striking similarity to the ordinary alternating current distribution system with primary high-pressure feeders, reducing transformers and secondary low-pressure distributing lines, the theory of high-pressure transmission being in both cases identical.

The pressures to be employed in the system under construction at St. Louis are approximately 5 pounds per square inch for the medium pressure feeders and from 20 to 80 pounds per square inch for the high-pressure suburban feeders. On account of the use of cast iron mains, the 5 pound limit was chosen for the medium pressure system, but for the high-pressure system iron pipe with screwed fittings will be used. With this construction any desirable pressure may be carried with entire safety and the radius of distribution extended to 100 miles if necessary.

In the medium pressure system, the gas pressure will be supplied by a blowing unit, consisting of a standard Connersville blower direct driven by a 300 H. P. Westinghouse horizontal gas engine. The engine is of the type recently brought out for high-power work and embodies a number of newly developed features which distinguish the construction of the horizontal type. The engine has two double-acting cylinders, 16½ inches in diameter and 24 stroke, arranged in tandem with a single crank. The engine uses for fuel the ordinary illuminating gas such as is distributed to customers and draws its supply directly from the gas main. The engine operates upon the four-stroke cycle and the method of governing secures a constant quality of explosive mixture at all loads, the quantity of the mixture being proportioned by the governor to the load on the engine. Electric ignition is employed.

In this particular installation the engine is controlled by an automatic pressure governor, which adjusts the speed of the unit in direct proportion to the demand for gas, the speed thus being in inverse proportion to the pressure in the distribution main. So sensitive is this control that the variation in pressure will not exceed 8 ounces for a 50 per cent. range in gas output.

The regular centrifugal speed governor is, however, also used in order to prevent, under any conditions, the engine running at excessive speed.

The St. Louis installation is one of the first of its kind in the illuminating gas field and presents many interesting features, which will be subsequently brought out in special articles at the completion of the work. The system has, however, long been in successful use in the distribution of natural gas over large districts adjacent to natural gas fields. The St. Louis system is in charge of W. A. Baehr, engineer of the Laclede Gas Light Company.

Notes.

An Ohio farmer has utilized a windmill to pump water and to compress air. The air is used to force the water for his house supply.

The Pennsylvania Pneumatic Pump Company is reported to have located a factory and office at Davenport, Iowa. It is stated that the factory will be built this spring and will employ about 60 men.

The Valley City Compressed Air Cleaning Company, of Grand Rapids, Mich., has just equipped its factory with new machinery throughout. This concern has only recently adopted a compressed air cleaning system.

A bill was recently introduced at the New York Legislature by Senator Ellsworth authorizing the construction of two pneumatic tubes between the New York Custom House and the appraiser's warehouse. In the ordinary course of business a great amount of correspondence passes between these two offices. It is now transported by carriage. The project has been endorsed by Collector Stranahan and Appraiser Whitehead.

The American Air Compressor Works, 26 Cortlandt street, have just issued a little booklet entitled "Valuable Information Regarding Compressed Air Installations." In addition to a brief description of that company's air compressors there is some valuable information for those who have occasion to use air compressors. The booklet is simply the forerunner of a new and complete catalog which is soon to be issued. A copy may be obtained upon application.

Some strong arguments in favor of compressed air locomotives for mine haulage are presented in a catalog just issued by the Baldwin Locomotive Works at Philadelphia. It is known as "Compressed Air Locomotives" and No. 46. In addition to cataloging the pneumatic locomotives made by this company, it gives a comprehensive description of the equipment necessary, together with some important information to those who are interested in the subject.

M. A. Grover, P. O. Box 590, Birmingham, Ala., writes us for information on intercoolers. He desires to know the capacity and square feet of cooling surface required by compressors of different capacities and pressures, and also the average water consumption for coolers. He is also interested to know the cubical capacity generally employed in receivers. COMPRESSED AIR will be glad to print any communications on this subject for the benefit of Mr. Grover and others of its readers.

The City of London, England, is considering the advisability of installing an extensive system of pneumatic tubes for the transmission of light parcels and letters. Starting from the general post-office, 90 miles of London streets may be equipped with 12-inch pneumatic tubes. The cost of the equipment will be, it is said, £2,250,000, and it is declared that the work can be completed within eighteen months. The scheme aims not only to improve the service by reducing the time required for the transport of letters, but to reduce the cost.

Among the recent English patents is one by Dawand Richardson for an apparatus for reheating compressed air. It consists of a furnace upon the upper end of which is an open casting or part composed of an outer wall of corrugated form. This is surrounded by a cover fitting over it so as to close the outer surface of the corrugations and produce a continuous worm or sinuous passage, the upper end of which is connected to the supply. The lower end is connected to the conduit leading to the machines in which the reheated compressed air is utilized.

A resident of Connecticut has patented a device which at least has the advantage of being novel. It is designed to be used on a trolley car to keep the tracks clear. A tank filled with compressed air is fastened to the bottom of the car. Pipes extend from this to the front of the car and at the end of each is a valve. This valve may be opened by the pressure of the motorman's foot on a button arranged in the woodwork of the platform. The object is to blow out of the way anything

that happens to be in front of the car. It has been impossible to obtain any information as to the results of this application in practice.

Sir W. G. Armstrong, Whitworth & Company, Limited, and E. W. Lloyd, have secured an English patent for valves for rapidly admitting compressed air or other gas from a reservoir to a machine. The primary object of this invention is to provide a valve for rapidly admitting air from a reservoir charged by a compressor to a torpedo tube to discharge the torpedo, but the valve may be used for other purposes. The invention consists in the combination of a valve nominally held close by the air pressure, a piston attached to the valve, a relief valve behind the piston, a knuckle joint and tumbler actuating the relief valve, a catch supporting the tumbler, and an electromagnet for withdrawing the catch.

A powerful compressed air clamp for submarine work was described in a recent issue of the *Scientific American*. It is utilized in crib work and for submarine construction and is employed for holding timbers together temporarily until they can be bolted into place. The clamp is usually handled by a crane and is placed in position with the cylinder end of the clamp above the timber. By merely turning a valve the compressed air forces the piston of the cylinder against the timber and clamps it securely until the bolts can be adjusted, when, by relaxing the air pressure, the piston is released and the crib can be at once removed to another position. It is said that by using this apparatus the services of a diver can often be dispensed with.

The Sullivan Machinery Company, Chicago, reports that, owing to the growth of its business, it is making several changes in the addresses of its different offices this spring to secure larger quarters and increased facilities. The New York office, Mr. A. E. Blackwood, Manager, is now located at 42 Broadway, Rooms 1427–28, instead of the Empire Building, 71 Broadway, where it has been located up to this time. On the first of April the Pittsburg office, Mr. Geo. W. Favor, Manager, will move from the Schmidt Building, 339 Fifth avenue, to the Farmers' Bank Building, where it will occupy Rooms 1112–13. On or about April 15th, the general offices, located heretofore at 135 Adams street, Chicago, will move into the newly completed Railway Exchange Building, at the corner of Jackson Boulevard and Michigan avenue, where they will occupy Rooms 1502–14, inclusive. Patrons and friends are cordially invited to call at the new quarters of the several offices.

An ingenious method of keeping the controller contact on electric street cars clean from dirt and copper dust, and thus preventing burnouts, has been devised by H. P. Wilkin, superintendent of motive power of the Camden Intercity Railway Company, which connects Huntington, W. Va., Cattlettsburg, Ky., and Ironton, Ohio. The device provides for the tap of the air brake exhaust into the controller casing. No changes are necessary in the control except the addition of a vertical duct or channel, which can either be made part of the casing or bolted on. The air brake exhaust port is tapped into the lower part of this duct and the nozzles connected with it are directly against the controller cylinder, another nozzle being placed close to the regular blow out magnetic coil at the bottom. These nozzles are made of an insulating material and differ in diameter, the smaller opening being near the bottom, thus allowing an even play of air into the controller from all the nozzles. Air is exhausted at the bottom of the casing and discharges through a pipe in the platform. Mr. Wellman has taken out a patent for his invention, and claims that it not only keeps the controller clean, but that it also muffles the noise of the exhaust, preventing the annoyance heretofore experienced to passengers and pedestrians and avoids the danger of frightening horses.

In the description of the masonry construction of the Blackwell's Island Bridge, which appeared in the *Engineering Record* of March 5th, it was noted that all the stone was dressed on the island by a force of 125 stone cutters. There were about 5,000 cubic yards of fine cut work, and it was all dressed by Kotten pneumatic machines operated by air from a Norwich compressor supplied with steam by a 60 horse-power boiler.

Small stones were dressed by these machines as they lay on the ground, but they were not high enough to clear the ends of coping stones 9 feet long, and special provision was made for them. The bed 5 feet wide, 5 feet deep and 16 feet long was dug and lined with concrete. Tracks were laid on the surface of the ground alongside the bed and the machines traveled on them to dress the upper ends of the long stones set vertically in the bed.

The most interesting use of these machines was to dress the 21½ x 21½ feet beds on top of the pedestal stones in position at a height of 125 feet above the water. These stones were set half an inch high and were required to be faced with great precision, although the truss shoes were seated on them with ¾-inch rust joints. The machines were set up on the pier tops and dressed the beds to within 1-50 of an inch, going over the surface till it was so perfect that there were no variations greater than the thickness of a sheet of thick paper and no hollows could be detected by a leveling rod or by moisture remaining after a shower. This work took about 10 days for each pedestal.

Experiments in using compressed air as power in small factories have been very successful, and European textile manufacturers are introducing the same more and more into their plants. About ten years ago an Austrian used compressed air for the first time extensively for this purpose in Paris, but as it was too expensive to produce, small factories could not take advantage of the invention, as was expected. The system of producing compressed air has, however, been revolutionized by an invention of a German mechanical engineer who tried to produce it by means of a jerking motive water. As the construction of the machine is very simple, the price of the apparatus is nearly 200 times lower than the one for the air compressors used heretofore. It consists of a low cylindrical vessel, from which a pipe leads from one side to a higher open tank. On the other side of the cylindrical vessel and opposite the entrance of the above pipe is another cylinder with a valve, thus forming the end of the pipe and letting the water out. The centre part of the apparatus is the pump room, with delivery and suction valve, and is separated from the water below by a membrane, which is forced up alternately by the motive water below and thereby forces the air from the pump room through an inlet valve into the highest part of the apparatus, which is the forcing head. From here a short pipe leads to the compressed air vessel with the manometer attached. In lowering the membrane a suction takes place in the pump room above the suction valve, and at the same height as the compressed air vessel is another vessel into which water enters in drops. The whole pump room is filled with water. By compound pressure the atmospheric pressure in small machines is tripled, and large machines have, of course, already, without the compound pressure, a higher atmospheric pressure. — Translated for *Fibre and Fabric* by E. O. Spindler.

Another use for compressed air on the modern trolley car is noted in the issue of the *Street Railway Journal* for March 12th. There is a description of the plant and equipment of the Pacific Electric Railway Company. On the cars of the long Beach line the Greenamyer pneumatic trolley pole controller is used. It is described in the *Street Railway Journal* as follows:

"The controller is operated by compressed air at any pressure above 60 pounds, supplied from the air-brake reservoir of the car, the consumption of air being very small. It holds the pole in firm contact with the trolley wire and keeps the same tension at all positions or altitudes, enabling cars to take curves at high speeds. It is stated that in actual tests and during several months' operation the trolley never runs off at any speed up to 60 m. p. h. on standard overhead construction unless there is a decided defect in overhead work. Even if it does come off it lowers itself instantly and automatically to a safe position below any spans. When it is desired to replace the trolley the conductor throws a three-way valve and the pole goes up with a very light pressure and assumes its normal pressure when the valve is thrown back. It has been demonstrated that the cost of operating the pneumatic trolley is practically nothing, as the damage resulting from burnt trolley wheels, broken or bent poles and broken overhead work and car roofs is almost entirely eliminated. The controller is very highly recommended by

the officials of the Pacific Electric Railway Company, whose recommendations are backed up by the results of many tests. It is said to have repeatedly carried 350 amps, during a run of seven miles at 60 m. p. h., with less than 5 volts drop and 27 pounds pressure at the trolley wheel. During a twenty-days continuous service test, conducted under the direct observation of R. S. Masson, consulting electrical engineer of the company, without a moment's attention, on a car speeded at 50 m. p. h. on a level straight track, carrying from 200 amps. to 300 amps. when running, and as high as 800 amps. on starting, traveling over 5,000 miles, it left the wire but once, and this was due to a loose inverted bell hanger. Its wheel was not scored or burned, no spark was even visible at the contact of wheel and wire. At present the trolley controller is not on the market, but is being developed in the shops of the Pacific Electric Railway Company. It will probably be installed on all the cars of the company."

One of the high officials of the fire department, who is conducting an independent inspection of the various New York theatres, expressed himself as being most highly pleased with the excellent condition in which he found the Proctor houses. "There are no theatres in the city," he said, "where a proportionately greater vacant floor space is found than in the Proctor houses." The safety of a theatre depends not so much on the number of its exits, but to their availability and arrangement. In the Proctor theatres it would be almost impossible to have a panic of serious proportions, since the space around the exits is cleared, and there are no narrow passages in which an excited crowd might become massed. The possibility of a blaze is reduced to a minimum by the adoption of every safety device, and this extra floor space further safeguards the audience by rendering impossible even a causeless panic.

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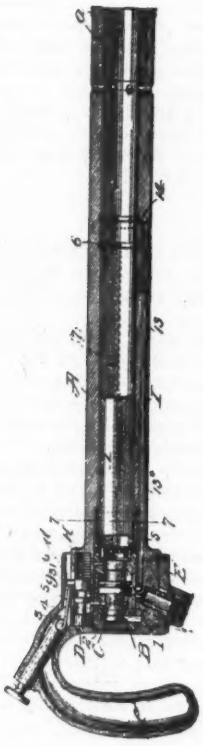
U. S. PATENTS GRANTED FEB., 1904.

Specially prepared for COMPRESSED AIR.

750,836. PNEUMATIC HAMMER. Francis K. Fassett, St. Louis, Mo., assignor to Leo Ehrlich, St. Louis, Mo. Filed Aug. 20, 1902. Serial No. 120,332.



A pneumatic hammer comprising a cylinder, a piston, a handle-base, and a nipple-plug introduced through an opening in the handle-base and into the cylinder for locking the parts together; substantially as described.

A pneumatic hammer, the combination with a cylinder and its piston, of a valve for admitting pressure behind the piston, said valve having an enlarged head, a port under control of the piston for admitting an impulse of pressure behind the enlarged head to move the valve, said valve in such initial movement opening a port for admitting live pressure behind said head, and a passage leading from the chamber behind the enlarged head of the valve to a port in the cylinder located in advance of the first-mentioned port, whereby, when the piston is in a forward position, the first-mentioned port is opened and the last-mentioned port closed, said last-mentioned port being opened by the piston when said piston is in position on its rearward stroke to relieve the pressure behind the enlarged head of the valve and render the same sensitive to action under opposing pressure; substantially as described.

750,852. PNEUMATIC ROAD-BED CLEANER. Eli S. Hart, Chicago, Ill. Filed Apr. 2, 1902. Serial No. 101,137.

A pneumatic road-bed cleaner for railways, the combination of a movable car, a suction-pipe mounted therein and provided with an inlet-opening arranged adjacent to the surface of the road-bed and extending across the track, an outlet-pipe connected with the suction-pipe and forming a continuation thereof, and means for forcing a jet of fluid under pressure into the outlet-pipe so as to create a partial vacuum therein, substantially as described.

750,919. WIND INSTRUMENT. Claudius Wadsworth, Jr., Brooklyn, N. Y. Filed Aug. 15, 1901. Serial No. 72,201.

750,967. SUPPORTING APPARATUS FOR IMPACT-TOOLS. Elias Gunnell, Chicago, Ill. Filed Apr. 23, 1902. Serial No. 104,735.

An impact tool holder comprising a movable carriage, a carrier-arm mounted at one end on the carriage and at its free end provided with a tool holding head mounted with universal angular movement on said arm, and stops to limit the angular motion in all directions.

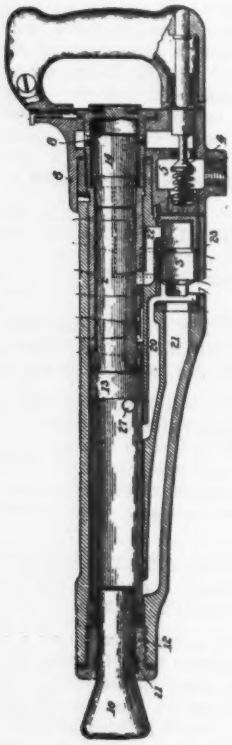
750,968. DUST-SPRAYING MACHINE. John R. Haldeman, Springfield, Mo. Filed Apr. 23, 1903. Serial No. 153,964.

A sprayer of the character set forth, a hopper, a blower adapted to be fed from the hopper, and a discharge-nozzle applied to the blower and comprising a ring or band having curved crossed strips, the curved portions of which are bent or twisted edgewise to scatter the discharging dust, substantially as described.

750,982. VALVE FOR PNEUMATIC TIRES. John E. Keller, Jr., Litchfield, Conn. Filed May 11, 1903. Serial No. 156,663.

The combination in a valve for pneumatic tires, of an outer tube adapted to encircle a tire-stem, an inner tube adapted for introduction within the tire-stem, said inner tube having a flange with a low or conical surface provided at the upper end thereof and adapted to clamp said tire-stem against said outer tube, a cap adapted to engage said outer tube, to draw it upward and force said inner tube downward into clamping position, a valve-seat provided on the under surface of said cap, and a valve adapted to contact with said seat.

751,072. PNEUMATIC HAMMER. Elias Gunnell, Chicago, Ill. Filed Aug. 5, 1901. Serial No. 70,973.



A fluid pressure impact tool, having a cylinder, a piston, means for exerting constant pressure upon said piston in the impact strokes thereof, and a tubular valve, controlled by the piston, for exerting intermittent pressure upon the forward end of said piston, to procure the reciprocation thereof, and supplemental exhaust ports checking the return stroke of the piston, substantially as described.

A fluid pressure impact tool, the combination with a piston chamber and appropriate passages, of a valve chamber located at the side of the piston chamber, and a tubular valve in said valve chamber controlling the inlet and exhaust from in front of said piston and provided with a small central pressure area to maintain it in normal position, a larger area communicating with large pressure fluid to push the valve forward to introduce said fluid in front of the hammer, and a still larger pressure area at the front of said valve to push it backward to exhaust the front of the piston chamber, substantially as described.

751,024. AUTOMATIC AIR-BRAKE. Benjamin Stapleton and John Ahern, Perry, Iowa. Filed Apr. 14, 1902. Serial No. 102,907.

An air-brake system, the combination of a pipe extending the full length of the train and recurving and provided at each end with a gage, and a leakage-groove within said pipe, adjacent to one of said gages, said pipe being in combination with a suitable air-supply.

The combination in an air-brake system, of a gage, a service-pipe extending to the end of the train and recurving and terminating in a second gage, a valved cross-pipe connection extending from near one end of said pipe to the other, a leakage-groove within said service-pipe, adjacent said last-mentioned gage, an emergency exhaust-cock in said pipe adjacent said last-mentioned gage, an engineer's brake-valve within said pipe system adjacent said first-mentioned gage, and a suitable air-supply in connection with said service-pipe, all arranged substantially as and for the purpose set forth.

751,096. VALVE. Joseph W. Nethery, Indianapolis, Ind., assignor to the Nethery Hydraulic Valve Company, Indianapolis, Ind., a Corporation of New Jersey. Filed Dec. 4, 1901. Serial No. 84,667.

751,229. PNEUMATICALLY-OPERATED MUSICAL APPARATUS. Edwin S. Votey, Summit, N. J., assignor to the Aeolian Company, New York, N. Y., a Corporation of Connecticut. Filed Apr. 15, 1903. Serial No. 152,638.

In combination in pneumatically-operated musical apparatus, and with means for producing the required flow and effective tension or pressure of the actuating-air, means for applying pneumatic pressure to vary and control the said effective tension or pressure, the last-said means including a passage-way independent of the first-said means.

751,253. TOOL FOR CLEANING DRILLED HOLES. Francis W. Brady, Englewood, N. J. Filed July 29, 1903. Serial No. 167,488.

A tool for the purpose specified, a box with a removable base, an aperture in its bottom, an annular chamber to catch and retain the borings and particles blown out, and an upright guide-sleeve, in combination with an air-pump having its nozzle extending down through said guide-sleeve.

751,261. MOTOR-OPERATED HAND-TOOL. Alfred W. Clarke, New York, N. Y. Filed Feb. 27, 1903. Serial No. 145,321.

A motor-driven hand-tool, comprising a motor, walls forming a storage-chamber for the motive fluid, said parts being in direct association with each other, and means for controlling the passage of the motive fluid to the motor.

A motor-driven hand-tool, comprising a barrel having a pressure-storage chamber therein, a motor juxtaposed to said chamber and located at the front portion of the hand-tool, means for controlling the passage of the fluid to the motor, and means communicating with the motor-exhaust and constituting a passage leading rearward to discharge the exhaust at the rear end of the hand-tool.

751,333. VALVE. Nicholas Obolensku, Hermitage, N. Y., assignor of fifty-one one-hundredths to John McGarvey, Rochester, N. Y. Filed Mar. 17, 1903. Serial No. 148,193.

751,364. VALVE. George R. Wilehart, The Dalles, Oreg., assignor of one-half to Frank J. Wilehart, The Dalles, Oreg. Filed May 20, 1903. Serial No. 158,053.

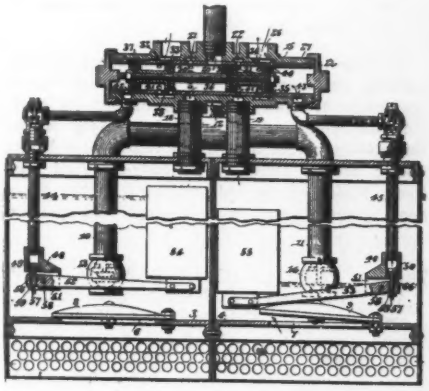
751,467. MOTORMAN'S VALVE. Fred B. Corey, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. Filed June 18, 1903. Serial No. 162,023.

A controlling-valve for air-brake systems, a valve structure comprising a valve-seat provided with suitable ports, a rotary valve mounted on the top of said seat, a chamber directly beneath the valve-seat supplied with air at main-reservoir pressure, and an automatic feed-valve for controlling the flow of air from said chamber to the train-pipe, the said valve having its operating parts inclosed in a casing located directly beneath said chamber and forming a continuation of the said valve structure.

751,572. HIGH-PRESSURE VALVE. Julius R. Tanner, Pittsburg, Pa. Filed Mar. 24, 1903. Serial No. 149,313.

751,573. PNEUMATIC STRAW-STACKER. James F. Templeton, Winnipeg, Canada. Filed Sept. 12, 1903. Serial No. 172,953.

751,626. WATER-ELEVATING APPARATUS. Horace L. Frost, Bristol, Tenn. Filed Oct. 3, 1901. Serial No. 77,480.



A water-elevating apparatus, the combination with separate water-chambers and water-passages leading therefrom, of means for leading compressed air to the chambers to force the water therefrom, a controlling-valve for the air, escape-passages leading from the chambers to permit the air escaping therefrom to shift the controlling-valve, escape-valves controlling the escape of air through said escape-passages, and valve-retaining means movable independently of the escape-valves and designed to prevent the opening of the

valves by said fluid-pressure within the chambers until the water has dropped to a predetermined level.

A water-elevating apparatus, the combination with the tanks and water-pipes, of a valve-casing formed with annular supply-channels in its interior face, and air-supply port piercing the walls of said casing intermediate of said channels, exhaust-ports piercing the wall of the casing, annular exhaust-channels communicating with the exhaust-ports, air-pipes extending from the tanks and communicating with the supply-channels of the casing, a lining-sleeve fitted within the casing and having an annular series of openings disposed opposite each of the supply-channels and two separated annular series of openings opposite each of the exhaust-channels, a shiftable controlling-valve provided with terminal and intermediate valve-heads, fitted within the lining-sleeve, and escape-pipes communicating with the interior of the valve-casing beyond the opposite ends of the valve, said valve being movable to permit the escape of air from the ends of the casing through the exhaust-ports.

751,627. PNEUMATIC BLOWER. David R. Gardiner, Neepawa, Canada. Filed Aug. 25, 1903. Serial No. 170,714.

A blower, a casing having a discharge chute or opening, an opening at one side thereof for introduction of straw, and an opening at the outer side for admission of air, and a rotary fan in said casing having a series of radial main blades and a central series of helically-arranged auxiliary blades at the side adjacent to the latter opening for drawing in air through said opening.

751,645. PNEUMATIC HYDRAULIC SEPARATOR. Frank W. Hopkins, Denver, Colo., assignor to the Colorado Iron Works Company, Denver Colo. Filed Apr. 2, 1903. Serial No. 150,826.

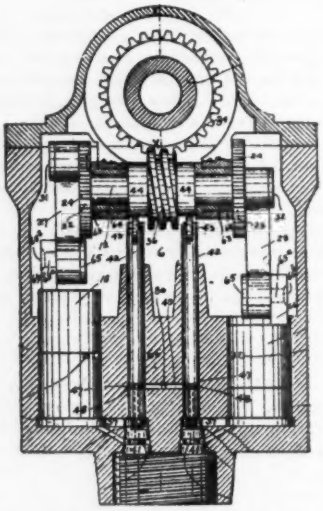
In combination the casing having the upper and lower outlets, means for introducing air into the casing extending throughout the entire cross-sectional area of the casing to diffuse the air gently throughout the entire mass of material, said casing being unobstructed for the passage of the material upwardly and downwardly according to weight, an inlet for the crushed material at a point below the surface of the liquid in the casing and a deflector or spreader extending across the inlet to spread the material issuing therefrom and to prevent the escape of the air therethrough, the air-introducing means being located at a distance below the deflector with a liquid-space intervening, substantially as described.

751,677. VALVE. Joseph W. Nethery, Indianapolis, Ind., assignor to the Nethery Hydraulic Valve Company, Indianapolis, Ind., a Corporation of New Jersey. Filed Aug. 10, 1903. Serial No. 168,894.

751,682. AIR-BRAKE COUPLING. John H. Phillips, Pottsville, Pa. Filed July 9, 1903. Serial No. 164,880.

A coupling device for railway-cars, comprising a coupling member normally held positively against lateral movement but rendered susceptible of lateral movement by engagement with a corresponding member.

751,980. MOTOR. Richard W. Funk, New York, N. Y., assignor to Hudson Machine and Pneumatic Tool Co., Jersey City, N. J., a Corporation of New Jersey. Filed May 10, 1902. Renewed July 14, 1903. Serial No. 165,527.



An improved motor, a driven shaft, a plurality of drive-shafts geared to the driven shaft and geared one to the other, a plurality of cylinders, pistons in the cylinders and operatively connected with the drive-shafts, feed-ports and exhaust-ports for the cylinders, valves for the feed-ports, and means controlled by said valves for releasing the pressure in said cylinders after exhaust.

752,000. BLOWER FOR GAS-MACHINES. Charles E. Sayre, Waterloo, and James W. Sayre, Hartley, Iowa. Filed June 6, 1902. Serial No. 110,424.

A blower consisting of a fixed water-tank, a rotary drum therein comprising outer and inner concentric cylinders and an interposed concentric wall dividing the space between the cylinders into outer and inner portions, substantially radial diaphragm-plates of equal number in both portions but non-alined, openings through the wall between adjacent plates connecting the rear end of each outer portion with the forward end of one inner portion, air-inlets through the outer cylinder at the forward end of each outer portion, air-outlets through the inner cylinder at the rear end of each inner portion, and an air-exhaust from the interior of said inner cylinder.

752,012. AUTOMATIC DEVICE FOR SETTING AIR-BRAKES ON STEAM-RAILWAY CARS. John M. Vance and Thomas Lanahan, Louisville, Ky., assignors of two-thirds to William T. Van Brunt and D. S. Harding, New York, N. Y. Filed May 26, 1903. Serial No. 158,801.

In combination with an air-brake system, of a device for automatically setting the brakes, comprising a framework of pipes mounted upon the truck and communicating with said air-brake system, a series of downwardly-projecting pipes connected to and in communication with said framework having their lower ends outside the road of travel, and a plug of fragile material secured upon the ends of said downwardly-projecting pipes adapted to control the escape of air therethrough, said plug consisting of a single casting having a shouldered portion intermediate of its length and a globular knob upon its extremities.

752,060. PNEUMATIC ACTION FOR MECHANICAL MUSICAL INSTRUMENTS AND PLAYERS. Merritt Gally, Brooklyn, N. Y. Filed Feb. 27, 1903. Serial No. 145,406.

A pneumatic action for an automatic or mechanical musical instrument or player; a pneumatic motor for each of a series of the sound-producing devices of a musical instrument; a tracker having a plurality of apertures, comprising a separate group for each sound-producing device; the pneumatic motor having a plurality of outlets with exhausting-valves; an inlet to reinflate the motor, having a valve normally closed, and means for closing all of the outlets when the inlet is opened.

752,071. FLUID-PRESSURE BRAKE. Edwin M. Herr, Pittsburg, Pa., assignor to the Westinghouse Air Brake Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed May 12, 1902. Serial No. 106,892.

A fluid pressure brake, the combination with a brake-cylinder having an outlet-passage and a pressure-reducing valve controlling said passage, of a sperarate speed-controlled valve device for governing the outlet from the brake-cylinder through the reducing-valve and adapted to normally hold said passage open at ordinary speeds.

752,111. AIR-BRAKE. William H. Sauvage, New York, N. Y., assignor of one-hundred-and-forty-nine two-hundredths to Gamaliel C. St. John and George F. Kissam, New York, N. Y. Filed Apr. 23, 1903. Serial No. 153,951.

A fluid-pressure brake system, the combination with a brake-lever system, of a main brake-cylinder, an auxiliary brake-cylinder and means controlled by the movement of the main-cylinder piston to admit air under pressure to the auxiliary cylinder to reinforce the main cylinder after the action of the main cylinder has begun, substantially as described.

752,112. AIR-BRAKE. William H. Sauvage, New York, N. Y., assignor of one-hundred-and-forty-nine two hundredths to Gamaliel C. St. John and George F. Kissam, New York, N. Y. Filed May 1, 1903. Serial No. 155,099.

A fluid-pressure brake system, the combination with a brake-lever system, of a brake-cylinder, an auxiliary reservoir, means to reinforce the action of the brake-cylinder, a valve to control the action of the reinforcing means, a plunger to open said valve, manually-operated devices to impart initial movement to the plunger, and means to admit air under pressure from the auxiliary reservoir behind the plunger through a port opened by the initial movement of the plunger, substantially as described.

752,176. VALVE. Joseph W. Nethery, Indianapolis, Ind., assignor to the Nethery Hydraulic Valve Company, Indianapolis, Ind., a Corporation of New Jersey. Filed Oct. 11, 1902. Serial No. 126,831.

752,201. FLUID-PRESSURE JACK. Niels A. Christensen, Milwaukee, Wis. Filed Mar. 2, 1901. Serial No. 49,630.

A fluid-pressure jack, the combination of a cylinder, a piston therein, means for admitting pressure to and releasing it from the cylinder, a pipe connected to the piston, and a removable piston-rod received by such pipe.

752,220. VALVE. Edward Halley, Montague, Mich., and Richard F. Downey, Milwaukee, Wis., assignors, by direct and mesne assignments, to National Valve Company, Milwaukee, Wis. Filed Feb. 9, 1903. Serial No. 142,538.

752,228. PNEUMATIC TIRE. Herbert E. Irwin, Galesburg, Ill., assignor to Irwin Rubber Company, Chicago, Ill., a Corporation of Illinois. Filed Sept. 16, 1903. Serial No. 173,374.

752,241. VALVE. James W. Master, Los Angeles, Cal. Filed Oct. 29, 1903. Serial No. 179,040.

752,662. PNEUMATIC MATTRESS-STUFFING MACHINE. Louis W. Ellman and John W. Morgan, San Antonio, Tex.; said Morgan assignor to James Lewis Davis. Filed Feb. 3, 1903. Serial No. 141,720.

A device of the class specified, the combination with a conveyer-tube having a flexible depending discharge-spout, of means at the inlet end of the tube for forcing fibrous material therein, and a tick engaging and clamping device disposed at the end of said discharge-spout.

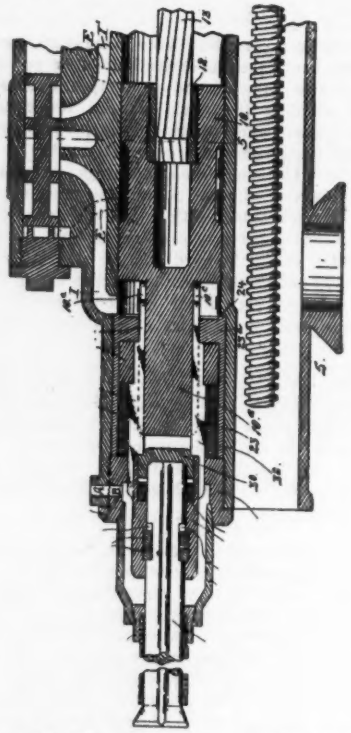
752,720. DIFFERENTIAL AIR-PRESSURE ELEVATOR. George F. Steedman, St. Louis, Mo. Filed Dec. 17, 1901. Serial No. 86,261.

An apparatus of the character described, the combination with a car, of a cylinder, a piston and piston-rod in said cylinder, the latter being connected to the car, means for constantly admitting pressure under the piston, means for admitting and exhausting pressure above the piston, and means for fully exhausting the pressure above the piston when the car is at its highest point; substantially as described.

752,790. PNEUMATIC BOLL-WEEVIL MACHINE. William B. Miller, Belton, Tex. Filed Apr. 2, 1903. Serial No. 150,832.

A device of the class described, the combination with a vacuum-chamber provided with exhaust devices, of mechanism for operating the devices, and a pair of spaced open-ended suction-conduits depending vertically from the vacuum-chamber and having their upper ends communicating therewith and their lower ends terminating short of and adjacent to the ground for gathering material directly therefrom, the walls of said conduits being wholly impervious.

752,819. ROCK-DRILLING MACHINE. Sanford W. Brothers, Denver, Colo. Filed Feb. 24, 1903. Serial No. 144,889.



A rock-drilling machine, the combination with the casing and a reciprocating piston therein, of a drill-holding chuck, and means for connecting the piston and chuck whereby they rotate together, but have independent longitudinal movement, said means comprising detachable keys mounted in seats formed in the chuck and engaging seats or grooves formed in the piston.

752,850. VALVE. Oscar S. McCurdy, Wilkinsburg, Pa. Filed Mar. 25, 1903. Serial No. 149,489.

752,954. PNEUMATIC SANDER. Ira P. Carnes, Lima, Ohio, assignor to Lima Locomotive and Machine Company, Lima, Ohio, a Corporation of Ohio. Filed Nov. 12, 1903. Serial No. 180,946.

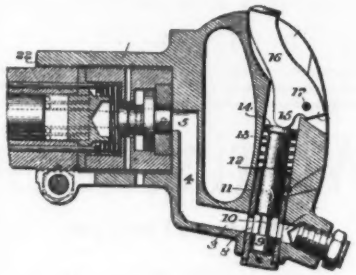
A sander comprising a casing having an integral nozzle and air-chamber, the wall of which is formed with duplex openings, one of which forms an air-inlet, and a plug extending through

the other of the openings for establishing communication between the airchamber and the nozzle and to permit of access to the nozzle.

752,976. DISTRIBUTING-VALVE FOR COMPRESSED-AIR BRAKES. Georges Houplain, Paris, France. Filed Sept. 18, 1902. Serial No. 123,924.

A distributing-valve mechanism for fluid-pressure railway-brakes comprising a piston for establishing communication between the auxiliary reservoir and the brake-cylinder, a piston for establishing communication between the brake-cylinder and the atmosphere, a chamber between the said pistons, and a spring-controlled valve in said chamber for regulating the passage of air from the train-pipe to the auxiliary cylinder.

752,982. HANDLE FOR PNEUMATIC TOOLS. Julius Keller, Philadelphia, Pa., assignor to Philadelphia Pneumatic Tool Company, a Corporation of New Jersey. Filed Sept. 9, 1902. Serial No. 122,673.



A handle for a pneumatic tool, having a pressure-supply duct located exterior to its grasping portion, a duct or passage leading therefrom to the interior of said tool, a passage located in the grasping portion of said handle, a bushing located in said passage, a throttle-valve stem in said bushing, a throttle-valve attached to said stem by a neck, said valve being outside the grasping portion of said handle, a slit in the upper portion of said handle, a lever pivoted in said slit and projecting from the upper portion of said handle, and a pressure-piece upon said lever adapted to underlie the workman's thumb or finger as he grasps said handle.

A pneumatic tool, a handle, a pressure-supply duct extending through said handle exteriorly to the grasping portion thereof, a throttle-valve bushing located in the grasping portion of said handle, a throttle-valve in said bushing, provided with a stem projecting upwardly from said valve and having a head thereon, a spring interposed between the upper end of said bushing and said head and means for operating said valve.

753,009. PNEUMATIC HORSE-COLLAR. Edward L. Sill, Woodward, Okla. Filed Jan. 22, 1903. Serial No. 140,095.

A pneumatic horse-collar consisting of a rigid frame consisting of two sections composed of two metallic sheets, a tube formed by curling the inner edges of the metallic sheets, straps connecting the two sections at their bottoms, an air-pad mounted upon the metallic sheets and a metallic rod whereby the air-pad is held within the tube, and straps whereby the air-pad is detachably connected to the rigid frame, substantially as and for the purposes specified.

753,020. BRAKE-VALVE. John V. Wells, Braddock, Pa. Filed Jan. 3, 1903. Serial No. 137,651.

A brake-valve, the combination of a casing having main-drum and train-line connections, a slide-valve mounted in the casing and having a port adapted to establish or break communication between said connections, a valve commanding said communication between the train-line and main drum, means controlled by the train-line pressure for operating the valve, the casing and slide valve having additional ports leading from communication with the train-line, and a pressure-relief device to which said ports lead and whereby the excess pressure of the train line is exhausted.

753,090. AIR-VALVE. Arthur McGonagle, East Orange, N. J. Filed Feb. 26, 1903. Serial No. 145,186.

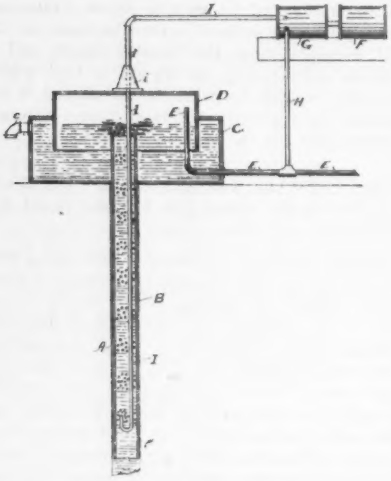
An air-valve device, the combination of a valve, an expansion-spring to which the valve is connected, an expansion-abutment against which one end of the said expansion-spring bears, and a casing in which these parts are mounted, substantially as set forth.

753,114. AIR-BRAKE-OPERATING DEVICE. George J. Berbert, New York, N. Y. Filed Jan. 8, 1903. Serial No. 138,190.

The combination with a railway-engine provided with the usual air-brake apparatus, of pipes connected with said apparatus and extending upwardly through the top of the cab at the opposite side thereof, and valve-casings connected with said pipes above the top of the cab and provided with valves having laterally-directed arms adapted to be operated by a semaphore arm

or signal located at the side of the track when in a position to indicate danger, substantially as shown and described.

753,045. METHOD OF OBTAINING GAS FROM WELLS. Augustus S. Cooper, Oakland Cal. Filed Dec. 12, 1902. Serial No. 134,933.



The method of obtaining gas from wells containing water with gas held in solution, which consists in lifting said water in the well by means of a hydrocarbon gas introduced under pressure into the water column below, and collecting the gas liberated from said lifted water.

753,159. VALVE FOR BLOWING-ENGINES. Alexander K. Rarig, Columbus, Ohio. Filed Mar. 2, 1903. Serial No. 145,733.

A blowing-engine, the combination with the valve between the compression-cylinder and the receiver and the positively-acting valve-gear therefor; of a yielding connection between the valve and its gear, a pressure-actuated valve-balancing piston connected with the valve, and means communicating pressure to the valve-balancing piston from the compression-cylinder.

753,215. VALVE. William H. Stratton, Hartford, Conn.; Cora M. Stratton, administratrix of said William H. Stratton, deceased. Filed Feb. 3, 1902. Serial No. 92,289.

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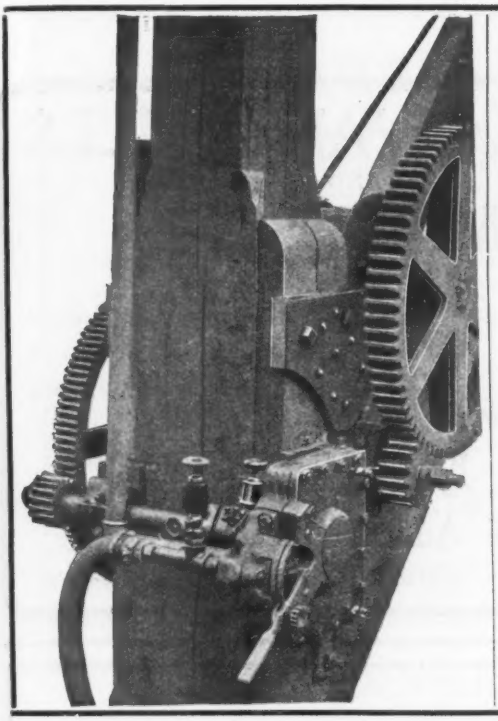

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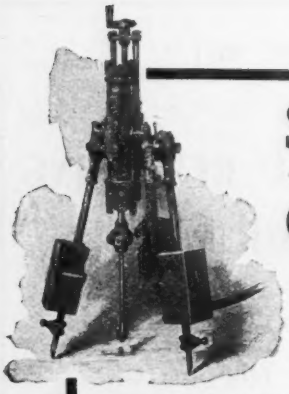

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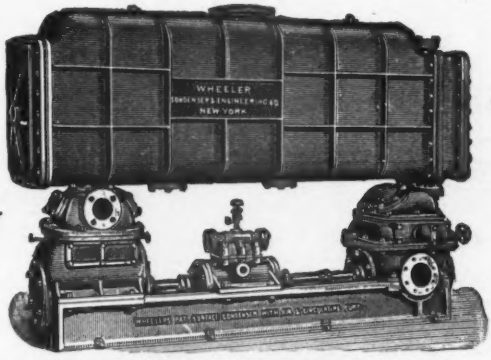

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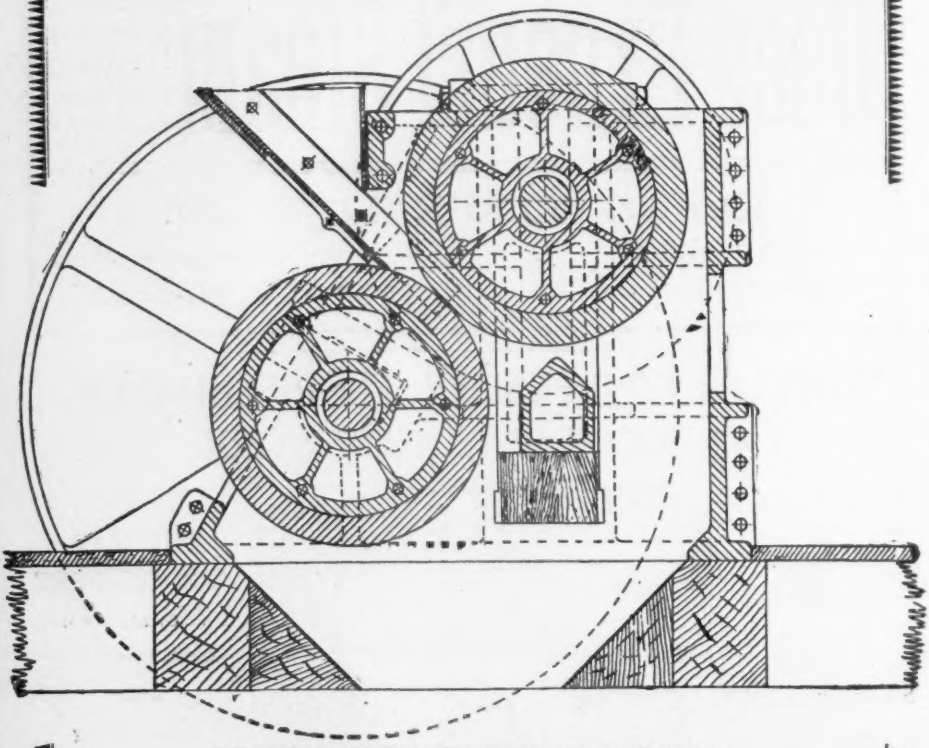

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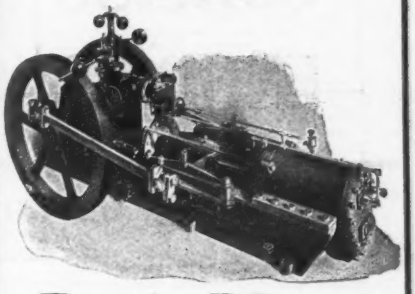

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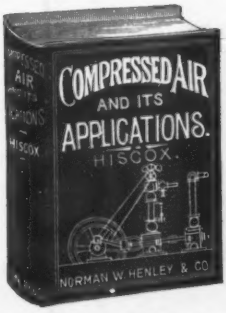

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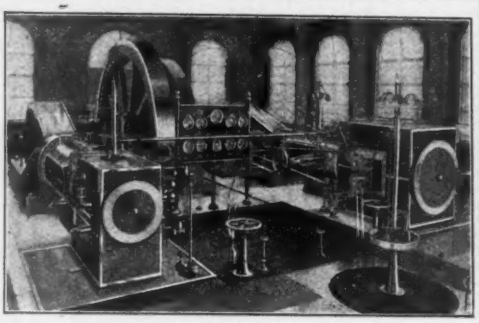

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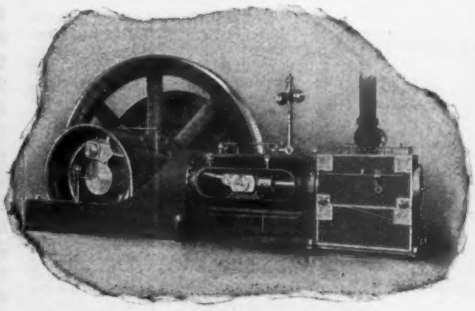

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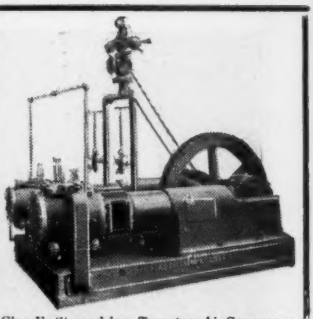

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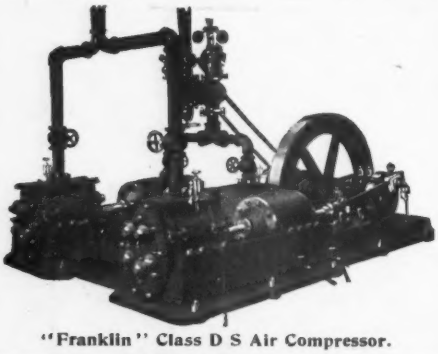

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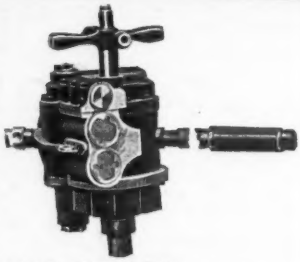

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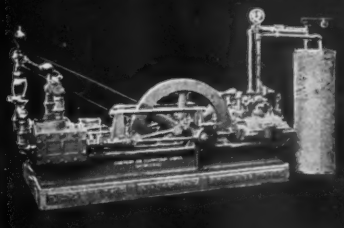

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